NEW LUNAR AND TIME TABLES

BY JAMES GORDON A.M.

10/-

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LUNAR AND TIME TABLES,

ADAPTED TO

NEW, SHORT, AND ACCURATE METHODS

FOR FINDING

THE LONGITUDE

BY

CHRONOMETERS AND LUNAR DISTANCES:

INCLUDING METHODS OF APPLYING CORRECTIONS TO A LUNAR DISTANCE FOR THE *SPHEROIDAL FIGURE* OF THE EARTH, THE APPARENT *ELLIPTICAL FORMS* OF THE SUN AND MOON, AND FOR THE *TEMPERATURE* AND *DENSITY* OF THE ATMOSPHERE.

WITH AN APPENDIX,

CONTAINING

FOUR ADDITIONAL NEW LUNAR METHODS,

DEMONSTRATIONS OF THE RULES, AND MATHEMATICAL FORMULÆ FOR CONSTRUCTING THE TABLES.

Approbed of by the Astronomer Royal, and others.

AND UNDER THE PATRONAGE OF

The Admiralty—The Board of Trade—The Trinity House—and Lloyd's.

BY

JAMES GORDON, A.M.,

TEACHER OF NAVIGATION AND NAUTICAL ASTRONOMY,

AUTHOR OF THE "EXAMINER FOR THE NATIONAL MARINE BOARDS,"

"CAPTAIN SUMNER'S METHOD OF FINDING A SHIP'S POSITION AT SEA IMPROVED AND SIMPLIFIED,"

"THE ELEMENTS OF TWO NEW COMETS," "THE ELEMENTS OF ARITHMETIC," &C.

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RECOMMENDATIONS OF THE WORK.

I.—*By the Astronomer Royal.*

THE *mathematical part*, as far as I see, *is correct* to terms of the second order, inclusively: which is the proper limit for Lunar calculations.

The practical application of the First Method is easy enough. It is *more accurate* than Mrs. Taylor's method; and the increase of trouble is so little that I should think any good navigator would prefer it: *I would do so myself.*

I am well satisfied with your First Method; and, I think, it may safely be used for lower altitudes than you have proposed.

(Signed) G. B. AIRY.

Note.—The above was written by PROFESSOR AIRY in 1839, when a specimen of the Tables was published, extending only to Altitudes of 15°; whereas they now extend to Altitudes of 7°. PROFESSOR A.'s remark regarding the present method being *more accurate* than Mrs. Taylor's method, equally applies to the similar methods of Thomson and others, as they are all founded on the same principles. J. G.

II.—*Certificate numerously signed by Experienced Commanders of Vessels.*

WE, the undersigned, having examined a specimen of Lunar and Time Tables, by JAMES GORDON, A.M., containing methods for correcting a Lunar Distance, and a method of finding the Time at Sea: Certify, that, in as far as known to us, these methods are new; and, that they will, in our opinion, be highly useful in conducting the calculations for finding the Longitude at Sea.

As the first two Lunar methods are short, and do not require proportional parts, a knowledge of them may soon be acquired; and the correcting a Lunar Distance by means of them will be an easy and brief process.

The method of finding the Time at Sea is the shortest and easiest of any known to us.

We, therefore, cordially testify that the Tables will be an important acquisition to practical Navigators.

III.—*Letter from* ADMIRAL SIR ARTHUR FARQUHAR.

ABSENCE from home must plead my apology for having so long delayed replying to your letter of the 20th ult., which you did me the honour to address to me on the subject of finding the Longitude by Lunar Distances, accompanied by a specimen of your Lunar Tables.

I have no hesitation in saying that, with practical seamen, in working Lunar observations, brevity is of the utmost consideration; provided correctness can be, at same time, secured; and which, in my opinion, your method completely accomplishes.

(Signed) ARTHUR FARQUHAR.

IV.—*Letter from* LIEUTENANT REID, R.N.,

(*One of the Officers in* CAPTAIN PARRY'S *expedition to discover the North West Passage*).

I HAVE examined your method of clearing a Lunar Distance, having applied it to several of my observations, and found the results were very correct and satisfactory.

I am much pleased with your new method, as being so plain, short, and correct; also of its requiring no proportioning, the operation being conducted by inspection, and the common Logarithms extended to only four places of decimals: properties of great importance to the practical navigator, from the great liability to err in using proportional parts.

Your method, by avoiding the use of a table of triple entry, such as that of Thomson and others, will be appreciated by practical seamen; and only requires to be known, to be universally adopted by them.

(Signed) ANDREW REID.

V.—*Letter from* GEORGE GRAINGER, ESQ., *late* H.E.I.C.S.

I HAVE carefully examined your method of working Lunar Distances, and have solved various examples by means of your Tables. I have no hesitation in saying that the method is, as far as I am aware, perfectly new; and possesses decided advantages over every other method with which I am acquainted. The method only requires the aid of a few special Tables, and the whole calculation is performed by inspection, and by means of the common Logarithmic tables, retaining only four places of decimals: it cannot, therefore, but recommend itself, at once, to practical seamen, from its extreme simplicity.

Farther, your concise Tables give your method a decided advantage over such works as that of Mendoza Rios; as also over those of Captain Thomson, Mrs. Taylor, &c., which contain a table of triple entry.

Your method being sound in principle, easy of application, requiring no hesitation from the computor, and one which none can fail to remember after solving a few examples: I believe I am only doing justice to yourself, and an essential service to seamen, in bearing the strongest testimony to its superiority over every other method which I have used or seen

(Signed) GEORGE A. GRAINGER.

VI.—*Letter from* CAPTAIN ANDERSON *of Aberdeen.*

I HAVE with much pleasure examined your method of working Lunar Distances, by applying it to many examples deduced from my own observations; and, by comparing the results deduced from the trigonometrical process with those obtained from your Tables, I have in every instance found your method gives an accurate and easy solution.

Conceiving, therefore, that your method, by avoiding such troublesome triple entry Tables as that of Thomson and others, and giving a short solution conducted entirely by inspection, will be acceptable to every practical seaman, I feel confident that, if once known, its merits will be generally appreciated.

(Signed) ROBERT ANDERSON.

FORMULA FOR FINDING THE TIME.

Latitude, ° ′
Declination,

1st arc, Half-cosine, ′ ″ (1)
2d arc, Half-cosine, (2)
True alt., Half-sine, (3)

Sum of (1) and (2), P. Log.
Diff. of (1) and (3), P. Log.

Meridian distance, h m s Log.

FORMULA FOR FIRST LUNAR METHOD.

☆'s app. alt., ° ′ ☽'s app. alt., ° ′
Ref., (IV.), — Dep., (I.), +

☆'s cor. alt., ☽'s cor. alt.,

° ′ ″
Apparent distance,
Aux. arc, (V.), ″, gives, (VI.), +
⊙'s, or planet's par., (VII.), +

Corrected distance, Sine, ... Tan.,
☆'s corrected alt., Cosec., ☽'s cor. alt. Cosec.,
☽'s hor. par., P. L., ... P. L.,

1st Dep., ′ ″ W., P. L., 2d Dep., P. L.,

2d Dep., W., when dist. *above* 90°.
. . ., E., when dist. *below* 90°.

Departure,
Hor. par. ″ + cor., (VIII.), W.,

Corrected departure, , added to cor. dist. if E.; but subtracted if W.

True distance,

PREFACE.

NUMEROUS methods having been proposed to perform the calculations in finding the Longitude at Sea by Chronometers and Lunar Distances, the Author feels called upon to give his reasons for thinking that the present work will be found worthy of the patronage of practical Navigators, as being superior to the other works of a similar kind presently used by them.

The common method of finding the Longitude by A CHRONOMETER is not very complicated; but the new method here given is shorter, as it merely requires a Table of Half Sines and Half Cosines (Table XVII.), consisting of only 7 pages, and two logarithms taken from the common table of Proportional Logarithms, to find the logarithm of the apparent time, without using the Polar distance. The Author, therefore, flatters himself that it will be found to be *the easiest* and *shortest method* yet published.

With regard to the methods of finding the Longitude from LUNAR DISTANCES, several methods are now in use. Those which give the *Correction* to be applied to the Apparent Distance, in order to obtain the True Distance, are the most highly esteemed by practical Navigators. As these methods are all similar to each other, although they differ slightly in form, we shall particularize only one of them, viz., THOMSON'S METHOD, in order to show what is deemed to be the superiority of the present Tables over others.

First, as regards *the mode of constructing the Tables.* Referring to Thomson's Tables, BARON ZACH, (in the Memoirs of the Royal Astronomical Society, VOL. IV., PART II.,) makes the following statement:—"The Author (Captain Thomson), does not explain the principles on which they are founded. I have not been able to discover the grounds on which the *third correction* is computed; and, indeed, it appears it has been determined in an indirect and empirical manner." This is confirmed by MR. COLEMAN (who has lately published Tables similar to those of Thomson), and claims having suggested the aforesaid indirect and empirical method to Captain Thomson. On this we may remark that Tables which are calculated by a long and tedious indirect method, such as that referred to, are very liable to contain errors: owing to the chance of the computer making mistakes being greater than when he uses direct mathematical formulæ, which afford him checks at certain intervals to test the accuracy of his calculations. *The first point of superiority,*

therefore, which is claimed for the present Tables, is that they are constructed from *mathematical formulæ discovered by the* AUTHOR, and which have been examined by *Mathematicians of the highest celebrity,* and *found to be correct.*

Second, that Captain Thomson's Tables *cannot give correct results in all cases* may be thus proved. The *third correction* depends upon the parallax of the Moon, whereas the changes in this element are entirely neglected in Thomson's Tables.

Thus, if the Apparent Distance be 20°, the apparent altitude of the Moon 20°, and the apparent altitude of the Star 20°, also the Moon's horizontal parallax 53′: then Captain Thomson's method of calculating his *third correction* is as follows.

The True Distance must first be calculated by any direct method: and it will be found to be = 19° 58′ 4″. Then the *first* and *second* corrections must be found: they are 4° 7′ 0″, and 5° 49′ 48″. These corrections being added to the apparent distance 20°, and 10° rejected, the sum is 19° 56′ 48″: the difference between which and the True Distance 19° 58′ 4″ is 1′ 16″ = the *third correction.* But, in Thomson's Table of the third correction, it is 1′ 28″: showing that he has not calculated his correction for parallax 53′.

Again, if we take the same Altitudes and Distance as above, but suppose the Moon's horizontal parallax to be 61′, the True Distance will be found to be 19° 57′ 57″: and the *first* and *second* corrections = 8° 59′ 0″ and 5° 57′ 20″. The sum of these corrections and Apparent Distance 20°, rejecting 10°, is 19° 56′ 20″: the difference between which and the True Distance 19° 57′ 57″, is 1′ 37″ = *third correction.*

Hence, when the Moon's parallax is 53′, the *third correction* is 1′ 16″; but, when the parallax is 61′, it is 1′ 41″, the difference of which is 21″.

Instead, therefore, of the correction remaining constant whatever the parallax of the Moon may be, it is shown here to vary 21″: neglecting the parallax, therefore, might occasion an error of 21″ in the Distance, or about 11 miles in Longitude.

The present method, however, takes into account the parallax of the Moon, and thus avoids the error above specified: this is *the second point of superiority* of our method.

Third, as regards *the form of the Tables.* Captain Thomson gives his *third correction* in the form of a table of triple entry: the arguments being the altitude of the Sun or Star, from 6° to 86°, at the top of the pages, the altitude of the Moon, from 6° to 86°, in the side column, and the Apparent Distance at the top of the two pages containing these altitudes. This form of a table often causes considerable trouble in finding the correction from it.

Thus, if the Apparent Distance is 21° 19′, the altitude of the Star, 6° 29′, and the altitude of the Moon, 24° 9′: the nearest to these in the Table are Dist., 20°, ✳'s alt., 6°, ☽'s alt., 24°; and, if the corresponding correction is taken, it is 6′ 5″; whereas it should be 5′ 25″, or 40″ less, which would give *an error* of about 20 MILES in *Longitude.*

To find the correction 5′ 25″, the requisite calculation is as follows:

Under Distance 20°,

✳'s alt. 6° and ☽'s alt. 24° give Correction,	=	6′ 5″
1° : 29′ : : — 1′ 9″ : Variation for 29′ of ✳'s alt.,	=	— 33
1° : 9′ : : + 14″ : Variation for 9′ of ☽'s alt.,	=	+ 2
Therefore, Dist. 20°, ✳'s alt. 6° 29′, and ☽'s alt. 24° 9′ give Correction,	=	5 34

In the above, the correction, opposite to ☽'s alt. 24° and under ✱'s alt. 6°, is 6′ 5″; and opposite same alt. of Moon and under 's alt. 7°, it is 4′ 56″. Therefore, the variation for 1° of ✱'s alt. is — 1′ 9″. Again, under ✱'s alt. 6° and opposite to ☽'s alt. 24°, the correction is 6′ 5″; and under same alt. of Star, and opposite to ☽'s alt. 25°, it is 6′ 19″. Therefore, the variation for 1° of ☽'s alt. is + 14″.

Again, under Distance 24°,

✱'s alt. 6° and ☽'s alt. 24° give Correction,	=	5′ 33″
1° : 29′ : : — 1′ 4″ : Variation for 29′ of ✱'s alt.,	=	— 31
1° : 9′ : : + 14″ : Variation for 9′ of ☽'s alt.,	=	+ 2
Therefore, Dist. 24°, ✱'s alt. 6° 29′, and ☽'s alt. 24° 9′ give Correction,	=	5 4

Hence,

as Dist. 20° and given altitudes give Correction,	=	5′ 34″
and Dist. 24° and given altitudes give Correction,	=	5 4
Variation for 4° of Dist.,	=	— 30
4° : 1° 19′ : : — 30″ : Variation for 1° 19′ of Dist.,	=	— 9″
But Dist. 20° and given altitudes give Correction,	=	5′ 34″
Therefore, given Dist. 21° 19′ and given altitudes give Correction,	=	5 25

But, even after performing all the above proportions, the correction, in many cases, is not accurately found; as appears from examining the tabular differences. Thus, for Dist. 20° and opposite to ☽'s alt. 24°, we have under ✱'s alt. 6°, the correction = 6′ 5″; under 7°, it is 4′ 56″; under 8°, it is 4′ 9″; under 9°, it is 3′ 28″, &c.: the differences of which are — 1′ 9″, — 47″, — 41″, &c. From which it appears that common proportion would not give the correct variation for the minutes of altitude not found in the table: as this must be corrected by the method of second differences, on account of the tabular differences varying considerably.

Such a table, therefore, as that of Thomson's would often occasion important errors if it is used by inspection; and to proportion accurately is troublesome. To remove this cause of error and difficulty in proportioning, we have formed two Tables (viz., V. and VI.), of double entry instead of a table of triple entry: from the first an auxiliary arc is found; and, by entering the second of these tables with this arc and the apparent distance, the correction of the Distance is obtained. These tables contain arcs which vary very little from each other; consequently, to use them, requires merely inspection: this is *the third point of superiority* of our method.

Fourth, with regard to *the length of the requisite calculation.* Captain Thomson has formed new tables: the one containing what he terms Logarithms of the Star's and Moon's altitude; and the other, the Logarithms of the Apparent Distance. Instead of these we use the common table of Logarithmic Sines, Tangents, &c. Captain T. also forms a table of Logarithms of the first and second arcs, and another of Logarithms of the Moon's horizontal parallax; instead of which, we use the common table of Proportional Logarithms. The retaining

the use of the common tables, with which practical Navigators are acquainted, instead of embarrassing them with new tables; and, at same time, not increasing the length of the calculation, is the *fourth point of superiority* of our method. It is true, that Captain Thomson has made all his corrections additive; we might have done the same; but he is obliged to give a distinction of cases as to entering his table of the Logarithms of the first and second corrections: our method of distinguishing the corrections by E. and W. has been preferred by those who have studied the present tables, as being equally easy and less liable to error than the former.

We may remark regarding MRS. TAYLOR'S tables (which are confessedly borrowed from the Cambridge Tables, the inaccuracy of which is universally admitted), that the Proportional Logarithm of the Moon's horizontal parallax, and Logarithmic cosecant of the Star's or Moon's altitude are added together and formed into a table. This, in appearance, shortens the calculation; but, in reality, it does not; as a proportional part for seconds of parallax must be added, which causes as much trouble as if the Proportional Logarithm of the parallax itself were added. There is, however, an important objection to this table; viz., that the proportional part for seconds of parallax is not constant, which may occasion an error of several miles in the Longitude. And thus an additional cause of error is introduced into this method.

The origin of all the tables referred to is what is called the CAMBRIDGE TABLES. These tables were calculated by LYONS, PARKINSON, and WILLIAMS, under the inspection of DR. SHEPHERD, Plumian Professor of Astronomy at Cambridge, by a rule formerly given by LYONS. MR. MARGETT afterwards published a set of *Linear Tables*, deduced from the Cambridge Tables. But both the Cambridge and Margett's Tables were large and expensive works; and, therefore, not well suited for general use. They were, consequently, modified by TURNER, THOMSON, NORIE, &c., and MRS. TAYLOR, without, however, introducing any new principle. As all the methods enumerated are merely copies or modifications of the Cambridge Tables, we have confined our remarks chiefly to one method, as the same remarks are equally applicable to the others.

The Author has departed from the usual course pursued in a Preface, by criticising the works of others: believing this, in the present case, to be absolutely necessary, as he could not expect those engaged in the nautical profession to have sufficient leisure to examine into the subject by themselves. Consequently, in order to show why the proposed method is deemed worthy of the patronage of practical Navigators, it is necessary to compare it with those already published; which could not be done without entering into particulars regarding the latter.

The Author, therefore, flatters himself that the present work will afford as easy a solution as any other yet published, of the important problem to find the Longitude at Sea: and, with these advantages, that the accuracy of the principles of the method may be relied on; and that, in its practical use, the liability to err is diminished.

With regard to the correctness of the tables themselves, the Author feels confident that few inaccuracies will be found in them, as the work has been in his hands for about 10 years, during which period it has been frequently revised: and, as to the execution of the work itself, he trusts that his experience as a Teacher of Navigation for upwards of 20 years has enabled him to give the Rules and Explanations in the form best suited for the purposes of study, either privately or in schools.

30, BASINGHALL STREET, LONDON,
April 2, 1849.

ADDENDUM.

To find the apparent time at the ship from the Sun's altitude.

Note. A method of solving this problem is given at pages 7 and 8; but, in order to verify the calculation, the following method may be employed.

METHOD II.

1. From the observed altitude of the Sun, find the true altitude, in the usual way. And, from the Nautical Almanac take the Sun's declination, reducing it to the given time at Greenwich.

2. If the Latitude and Declination are of the same name, take their difference; but if they are of opposite names, take their sum. The result is the Sun's meridian zenith distance.

3. From the Half-Cosine of the Sun's meridian zenith distance, subtract the Half-Sine of the Sun's corrected Altitude, (Table XVII); and find the Proportional Logarithm of the remainder. To this logarithm add the Logarithmic Cosines of the Latitude and Sun's declination; the sum, rejecting 20 in the index, being subtracted from the constant logarithm 10·0334 will give the Logarithm of the Sun's meridian distance, (Table XVIII): which is the Apparent time at the ship, if the altitude be taken in the afternoon; but subtract it from 24^h, and the remainder is the Apparent time past noon of the preceding day, if the altitude is taken in the morning.

EXAMPLE.

In Latitude 41° 20′ N, the Sun's true altitude in the afternoon was found to be 18° 5′. Required the apparent time at the ship, the Sun's declination being 12° 13′ N.

Latitude,	41°	20′ N.	. . . . .		Cos.	9·8756
Declination,	12	13 N.	. . . . .		Cos.	9·9901
Difference,	29	7	Half-Cosine,	72′	48″		
⊙'s Altitude,	18	5	Half-Sine,	25	52		
			Difference,	46	56	Prop. Log.	0·5838
							0·4495
						Constant Log.	10·0334
Meridian Distance = Apparent time,			= $5^h\ 6^m\ 10^s$			Log.	9·5839

Note. By Example I., page 8, the apparent time is found, by Method I., to be $5^h\ 6^m\ 10^s$. If another table were formed by subtracting the Logarithms in Table XVIII. from the constant logarithm 10·0334; this table would contain 0·4495 opposite $5^h\ 6^m\ 10^s$, and thus the calculation would be abridged. Or another table, instead of Table XVII., might be formed, containing arcs equivalent to Sines and Cosines; and then another table substituted instead of Table XVIII. for the logarithms of the meridian distance. The latter is the method which will be used by the author in his work entitled "CAPTAIN SUMNER'S METHOD OF FINDING A SHIP'S POSITION AT SEA IMPROVED AND SIMPLIFIED." The same method will be there applied to finding the Latitude by Double Altitudes.

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SECTION I.

ON FINDING THE LONGITUDE BY OBSERVATION.

ARTICLE I.

VARIOUS methods have been proposed for finding the longitude, depending on the general principle: that the difference of the times at two places, converted into degrees, minutes, and seconds, at the rate of 15 degrees of space to 1 hour of time, will be the difference of longitude.

ARTICLE II.

This principle depends on the fact that the Sun appears, in his daily motion, to move round the Earth, from east to west, in 24 hours; and, consequently, passes betwixt two meridians, which are distant 15 degrees from each other, in 1 hour, and over any other space in the same proportion of 15 degrees to 1 hour.

When the Sun is on the meridian of a place, it is noon at that place; and as longitudes are reckoned from the meridian of Greenwich, and the Sun comes to those meridians situated to the eastward so much the sooner, it is evident that at any instant of absolute time, the difference betwixt the time at any place and that at Greenwich, will give the longitude of the place; which may be reduced into space at the rate of 15 degrees to 1 hour, and reckoning the longitude east or west, according as the time at the place is greater or less than that at Greenwich.

If, however, the result thus found, exceeds 180°, subtract it from 360°, and the remainder is the longitude, but of a contrary name to that found by the preceding Rule (see Art. XX. page 5).

ARTICLE III.

It is also evident that the time at Greenwich corresponding to a given time at a given place, may be found by converting the longitude of the place into time, and adding this to the given time, if the longitude is west; but subtracting it from the given time, if the longitude is east: observing that in east longitude, when the longitude in time exceeds the given time, 24 hours must be added to the latter, then subtract as before, and the remainder is the time at Greenwich reckoned past noon of the preceding day; but, in west longitude, when the sum of the longitude in time, and the given time exceeds 24 hours, take 24 hours from it, and the remainder will be the time at Greenwich past noon of the following day.

ARTICLE IV.

The apparent daily motion of the Sun in the heavens marks *Apparent time*, so that when he is on the meridian of any place, it is apparent noon at that place, and when he returns to it again, the elapsed time is the length of an apparent solar day.

ARTICLE V.

If the Sun moved in the equator with a uniform motion, all the solar days would be of the same space of absolute time; but as the Sun actually moves in the ecliptic, which is inclined to the

equator, equal spaces in the ecliptic will give unequal spaces on the equator; and farther, the Sun's motion in the ecliptic is not uniform. From both of these causes, the intervals of apparent time, corresponding to a given interval of absolute time, are not uniform. But if we conceive an assumed sun to move in the equator with a uniform motion, the rate being the average of that of the real sun in the ecliptic, the intervals of time that would be marked by this sun would be uniform; and, consequently, the time, as denoted by it, is called *Mean time.*

ARTICLE VI.

The difference betwixt mean time and apparent time is called the equation of time, and this is given in Page I of the Nautical Almanac for apparent noon, and at Page II for mean noon of every month of the year: it being additive or subtractive as denoted at the top of the Page. At four times in the course of the year, mean and apparent time agree, the actual rate of motion of the sun in the ecliptic when reduced to the equator, being then the same as that of the assumed sun which marks mean time. The times in 1849, will be found to happen on April 14, June 14, August 31, and December 24: the equation of time being then 0. Betwixt the first and second of these dates, the equation of time is subtractive from apparent time; betwixt the second and third it is additive; betwixt the third and fourth, it is subtractive; and for the remainder of the year, not included in these intervals, it is additive. In each of these intervals, the equation of time commences from 0, and increases until it arrives at a maximum, when it then diminishes until it again becomes 0: the four maximum values are — 3′ 55″. 21 on May 14, + 6′ 11″. 28 on July 26, — 16′ 16″. 57 on November 3, and + 14′ 32″. 10 on February 11.

ARTICLE VII.

If a clock or chronometer always shows 12 hours when the assumed mean sun is on the meridian, it is said to be regulated to mean time; if it differs constantly by the same portion of time, this difference is the error of the chronometer, which is fast or slow according as the time by it is greater or less than mean time. And when the error is fast, and increases, the chronometer is gaining on mean time; but when it diminishes, it is losing: when the error is slow, and increases, the chronometer is losing on mean time; but when it is diminishing, it is gaining; this gain or loss when noted for intervals of 24 hours is called the daily rate of the chronometer.

ARTICLE VIII.

Thus by comparing a chronometer with a clock regulated to mean time, the error and rate is ascertained; and from these the time at Greenwich may be found corresponding to any given time as shown by such a chronometer, as follows: to the given time, apply the error of the chronometer, by addition or subtraction, according as the error is slow or fast; and find what is called the accumulated rate, viz. the daily rate multiplied by the number of days which has elapsed since the error was observed, and add this to, or subtract it from the time formerly found, according as the chronometer is losing or gaining, the result will give the mean time at Greenwich.

ARTICLE IX.

As fixed stars have no annual motion in the heavens, they will perform their daily revolutions from any one meridian to the same meridian in uniform portions of time, these intervals are Siderial days, consisting each of 24 hours of Siderial time. As the assumed mean sun moves at a uniform rate to the eastward on the equator, amounting to 360° in one year, the mean Solar day will exceed the Siderial day by the daily rate at which the sun advances; this is 3′ 55″. 9094, the Siderial day being 23^h 56′ 4″. 0906 of mean time.

ARTICLE X.

The Right Ascension of a heavenly body being the arch of the equator, reckoned eastward, from Aries to the meridian passing through the body, it is evident that the difference between the right ascensions of the sun and a fixed star will be the same as the difference between the apparent

time, as shown by the sun, and the Siderial time expressed by the distance which the star is to the westward of the meridian of any place.

ARTICLE XI.

If to the star's right ascension, when westward of the meridian, we add its meridian distance, the sum is called the right ascension of the meridian of the place, when diminished by 24 hours, if it exceeds that quantity; but when the star is eastward of the meridian, from its right ascension, (increased by 24 hours if necessary), subtract the meridian distance of the star, the remainder is the right ascension of the meridian; and, if from the right ascension of the meridian, (increased by 24 hours, if necessary) we subtract the sun's right ascension, the remainder is the distance of the sun to the westward of the meridian of the place, or the apparent time. The same is applicable in the case of the moon or any of the planets.

Besides the distinction of time into apparent, mean and siderial, there are three different modes of reckoning time with respect to the commencement of the day; these are called the *civil, astronomical,* and *nautical* modes of reckoning time.

ARTICLE XII.

The *civil day,* which is that adopted for the usual purposes of business, begins at midnight, and ends at the midnight following; it is divided into two parts of 12 hours each; the first 12 are marked A. M., signifying *ante meridiem,* i. e. *before the meridian or noon;* and the other 12 are marked P. M., signifying *post meridiem,* i. e. *after the meridian or noon.*

ARTICLE XIII.

The *astronomical day,* which is the mode of reckoning adopted in the Nautical Almanac, and by Astronomers, commences 12 hours later than the civil day, being at noon of that day, and is reckoned continuously to 24 hours, which makes it terminate 12 hours later than the civil day, being at noon of the following day. Hence, July 10th at 10 H., P. M., civil time, is July 10th at 10 H., *astronomical* time; but July 11 at 10 H., A.M., is July 10th at 22 H., *astronomical* time. Consequently, for the first 12 hours of the astronomical day, or from noon to midnight, the day of the month and hour of the day are the same as in the civil reckoning; but for the last 12 hours, or from midnight to noon, the day of the month by the civil reckoning is one day in advance of that by the astronomical, and the hours differ, as in the former they commence from 0 and continue to 12, whereas in the latter they commence from 12 and continue to 24.

ARTICLE XIV.

The *nautical day* or *sea day,* is adopted by seamen in their log books; it commences 12 hours before the civil day, or at noon of the preceding day, and terminates 12 hours before the civil day, or at noon of the civil day; it is divided into two parts of 12 hours each, the first is marked P. M., and the other A. M. Hence, July 10th, at 10 H., P. M., civil time, is July 11th, at 10 H., P. M., nautical time; and July 11th at 10 H., A. M., civil time, is July 11th at 10 H., A. M., nautical time. Consequently, for the first 12 hours of the nautical day, the day of the month is one day more than in the civil mode of reckoning; but for the last 12 hours, it is the same in both; the hours are numbered and marked the same in both methods.

ARTICLE XV.

It appears, therefore, that *noon* of the *civil* day, the *commencement* of the *astronomical* day, and *termination* of the nautical day, take place at the same instant.

Log books in ships in the royal navy, and in some merchantmen, are dated the same as the civil day; but make up the day's work, as usual, at noon, i. e. at the middle of the civil day.

ARTICLE XVI.

From what precedes, it appears that the longitude of a place may be found, if we can ascertain

the mean times at *the given place* and *Greenwich*, corresponding to the same instant of absolute time: See Art. II.

ARTICLE XVII.

The mean time at any place may be ascertained by observation. The time shown by a sun dial is apparent time, but this is not sufficiently accurate for the purpose of finding the longitude. The usual mode of ascertaining the time at any place by means of the sun is to take his altitude by a quadrant or sextant, from which the apparent time is deduced by a Rule which is afterwards given (Sect. II.), and hence the mean time is known by applying the equation of time.

The mean time may also be ascertained by means of an altitude of a Fixed Star, a Planet, or the Moon (Sect. II.).

ARTICLE XVIII.

The mean time at Greenwich may be ascertained by means of a chronometer, or by observation. When an altitude is taken, as referred to in Art. XVII., the time by the chronometer is noted, from which the time at Greenwich is found, as in Art. VIII.; and the mean time at the place being found, as in Art. XVII., we thence deduce the longitude, as in Art. II. This is said to be finding the longitude by chronometers.

ARTICLE XIX.

The mean time at Greenwich may also be found by means of observations of different kinds. If observations are made of those phenomena which happen at the same instant of absolute time to all places on the surface of the Earth, and of which the Greenwich times are noted in the Nautical Almanac, it is evident that the Greenwich time being thus known, the error of the chronometer, for Greenwich mean time, may be ascertained, independently of the original error; and hence the longitude is found as in Art. XVIII. Phenomena, of the kind referred to, are Eclipses of the Moon, Eclipses of the Satellites of Jupiter, and Distances between the Moon and Sun or any of the Planets or a Fixed Star.

ARTICLE XX.

Eclipses of the satellites of Jupiter, however, are only visible through a Telescope of such magnifying power, that the field of view is thereby very limited, and thus on board of ship, it is very difficult to keep the satellite in view so as to ascertain the exact time when the eclipse happens. The only mode of practically making use of this method of finding the longitude is to catch sights of the satellite from time to time, until the eclipse has happened; and, from the last time when the satellite was seen not eclipsed, the time of the eclipse might be estimated within a certain error. Thus, if, on September 23, 1849, at $12^h\ 3'\ 14''$ by a chronometer, the Ist. satellite of Jupiter is seen not to be eclipsed; but at $12^h\ 3'\ 20''$, on again catching a sight of Jupiter, the Ist. satellite is not visible, having become immersed in the shadow of Jupiter, it is evident that the immersion must have happened at some time intermediate between these noted times; and, if we take $12^h\ 3'\ 14''$ as the time of the eclipse, the error cannot exceed $6''$, the difference of these times, which would give an error of $1'\ 30''$, at the greatest estimation, in the longitude found therefrom.

By page 20 of the Nautical Almanac, the immersion of the Ist. satellite of Jupiter takes place on

September 23 at	22^h	$40'$	$9''.5$
and by the chronometer, as above, ... at	12	3	14
Hence, the error of the chronometer, slow of Greenwich mean time, . . is	10	36	55.5

If, at another period of the same day, the altitude of the sun is taken, and the mean time at the ship found (Sect. II.), to be $3^h\ 15'\ 5''$, while the same chronometer shows $13^h\ 4'\ 15''$, the longitude may be thus found, supposing the rate of the chronometer to be $12''$, losing daily.

Time by the chronometer, when sun's altitude is taken, . . .	13h	4′	15″
Error of the chronometer, slow of Greenwich mean time, at 12h 3′ 14″ per chron.,	10	36	55.5
Mean time at Greenwich, when sun's alt. is taken, if the chron. had no rate,	23	41	10.5
Proportional part of rate for elapsed time, 1h 1′ 1″, or say 1h, is 0″.5, the daily rate being 12″ losing, and this must consequently be added to the above time, ...			0.5
Mean time at Greenwich, when the sun's alt. is taken, . . .	23	41	11
Mean time at ship, do.	3	15	5
Longitude of the ship in time, by Art. II., ...	20	26	6W

= 306° 31′ 30″ W, which taken from 360°, gives the longitude 53° 28′ 30″ E. The longitude having been brought out to exceed 180°, shows that a day has been lost in the ship's reckoning: instead of the time at the ship being September 23, at 3h 15′ 5″, it should have been stated at September 24, at 3h 15′ 5″. Hence, mean time at the ship being September 24, at 3h 15′ 5″, or

September 23, ... at	27h	15′	5″
And mean time at Greenwich, as above, ...	23	41	11
The longitude of the ship in time is, by Art. II., ...	3	33	54E

= 53° 28′ 30″E, as before.

If the longitude should be brought out as exceeding 180° E, this would show that a day had been gained in the ship's reckoning, which must be corrected accordingly, by deducting one day from it. The gaining or losing a day in the ship's reckoning arises from the ship sailing to the eastward or westward, until the meridian opposite to that of Greenwich is passed. Thus, if the ship sails to the eastward, the time at the ship will exceed that at Greenwich by an increasing quantity, until the ship arrives at the opposite meridian, when the excess will be 12h; after which, if the ship makes an additional easting of 15°, the excess would be 13h, and the longitude 195° E: the longitude might thus be reckoned on as East, until it amounted to 360°, and the day of the month retained the same as by ship's reckoning. But, to preserve the distinction of longitudes into E and W, not exceeding 180°, when the longitude exceeds 180° E, it is then converted into west longitude, by subtracting it from 360°; thus 195° E will give 175° W, and the time at the ship, instead of being reckoned as exceeding the time at Greenwich by 13h, should then be taken as less by 11h; and the day of the month made 1 less than according to that shown previously by the ship's reckoning. The contrary is the case when the ship sails to the westward.

It is evident that, if a ship sailed continuously to the eastward, until it has made a complete revolution of the earth, it would have made one revolution, in space, more than the earth itself in its daily motion from west to east; and as these revolutions mark the days of the month, the ship's reckoning will have gained exactly one day; and if the ship sails to the westward, one day in the reckoning will be lost, on her return to the meridian first departed from: to avoid this difference in the mode of reckoning time, the change of the day as also of the name of the longitude is made, when the ship has made the meridian opposite to that of Greenwich.

ARTICLE XXI.

From the objections to observations of the eclipses of Jupiter's satellites, stated in Art. 20, and that eclipses of the Moon happen so seldom as not to afford ready means to the seaman for discovering his longitude, the method of finding the longitude by means of Lunar distances is that generally resorted to.

ARTICLE XXII.

Lunar distances are the distances betwixt the Moon's centre, and that of the Sun, and certain fixed stars or the planets, as would be observed by a person situated at the centre of the Earth,

were it possible to make such observations: these distances are given for every 3 hours of Greenwich mean time at pages XIII. to XVIII. of every month, in the Nautical Almanac, from which the distances may be computed, by proportion, for any other times.

The distance between the Moon's limb and a fixed star may be taken by means of a sextant and by adding to this, or subtracting for it, the Moon's semi-diameter, according as the distance of the nearest limb, or the farthest limb of the Moon was taken from the star, the distance between the centre of the Moon and star will be found. This distance is affected by the refraction of the atmosphere, the observed distance being less than what it would have been had there been no atmosphere: the difference on this account is called the correction for refraction. The distance, being observed on the surface of the earth, must also differ from what it would be if taken at the Earth's centre, from the difference in the positions of the bodies as viewed from these different points: this difference in position is called parallax, and the correction of the distance on this account, is called the correction for parallax.

An observed distance is also called apparent, and when it is corrected for refraction and parallax, and thus reduced to what it would be when observed at the centre of the Earth, it is called the true distance: such distances are the same as those given in the Nautical Almanac, and are the same at the same instant of absolute time, at whatever place on the surface of the Earth the distance may have been observed.

It is, therefore, evident that if we note the time by a chronometer when a Lunar distance is taken, and compute the true distance, we can, from the Nautical Almanac, find the mean time at Greenwich, when this true distance happens; and hence the error of the chronometer, from which the longitude is found as in Art. II.

ARTICLE XXIII.

The Moon's daily motion in her orbit being about 13°, this will give for 1 hour about 30′, or for 1 minute of time 30″ of change of the moon's distance from a fixed star situated near the Moon's orbit; but 1 minute of time gives 15 miles of longitude; therefore, a change of 30″ of distance will give 15 miles of longitude, and 2″ of distance gives 1 mile of longitude. These results are sufficiently accurate for estimating the degree of correctness within which Lunar distances will determine the longitude; and it follows, that if the distances observed, and those contained in the Nautical Almanac, do not differ from the truth more than 30″, the longitude may be ascertained within 15 miles.

ARTICLE XXIV.

The Moon's motion being so quick as now stated, makes her a suitable body for using her distances from the Sun, the planets or fixed stars which lie near her orbit; it being necessary to select such as are nearly in this situation, otherwise the effect of the Moon's motion may be lost to an extent which would render the observation useless in determining the longitude with the requisite degree of accuracy. The stars selected for this purpose, in the Nautical Almanac, are *α Arietis, Aldebaran, Pollux, Regulus, Spica Virginis, Antares, α Aquilæ, Fomalhaut,* and *α Pegasi,* and the *Planets* are *Venus, Mars, Jupiter* and *Saturn.*

SECTION II.

ON FINDING THE MEAN TIME BY AN ALTITUDE.

ARTICLE I.

To find the Mean Time by an Altitude of the Sun. See Abbendix III

PRELIMINARY RULES.

1. Find the mean time at Greenwich by either of the following methods: with the estimated longitude and apparent time at the ship when the altitude of the Sun is taken, find the corresponding apparent time at Greenwich by the Rule in Article 3, Sect. I; and thence the mean time by applying the equation of time, taken from Page I. of the Nautical Almanac. Or, from the time as shewn by a chronometer, find the mean time at Greenwich, by Article 8, Sect. I.

2. From the observed altitude of the Sun's lower limb, subtract the Dip of the Horizon (Table III.), and refraction (IV.), and to the remainder add the Sun's parallax in altitude (III.), then add the Sun's semi-diameter taken from Page II. of the Nautical Almanac: the sum will be the true altitude of the Sun's centre. Or, the correction for Dip, Refraction, Parallax, and Semi-diameter, may be nearly found at once by Table XVI., and added to the observed altitude of the Sun's lower limb.

3. Take out the Sun's declination, for the preceeding noon at Greenwich from Page II. of the Nautical Almanac, and correct it for Greenwich mean time by Table XIII., or by means of the daily variation, and Table XIX., or by multiplying the hourly difference taken from the Almanac by the number of hours in the Greenwich time.

4. Take out the equation of time from Page I. of the Almanac, and correct it for the Greenwich time by Table XIV., or by means of the hourly difference given in the Almanac.

Then proceed as follows:—

RULES.

1. If the sun's declination and the latitude are of the same name, first subtract the less from the greater, and then add them; but if they are of contrary names, first add them, and then subtract the less from the greater: the *first* and *second arcs* will thus be obtained. Below these write the sun's true altitude.

Note. The *first arc* is found, by the above rule, exactly as a *difference of latitude*, the latitude of the ship and sun's declination being reckoned as the two latitudes.

2. Find (XVII.) the *half cosines* of the *first* and *second* arcs, and the *half sine* of the *true altitude*. Then add together the two *half cosines*, and subtract the *half sine* of the true altitude from the *half cosine* of the first arc.

Note. When the *second arc* exceeds 90°, subtract it from 180°, to find its supplement, and subtract the half-cosine of this supplement from the half-cosine of the *first arc*, instead of adding them as in the Rule. This will happen only when the Declination exceeds the distance of the ship from the Pole.

3. Find the proportional logarithms (X.) of this sum and difference, adding 10 to the index of the former; and the difference between these logarithms is the logarithm of the *Meridian distance*, which will be found in Table XVIII.

This meridian distance is the *Apparent time* at the ship, if the altitude was taken in the afternoon; but, if in the forenoon, subtract the meridian distance from 24 hours, the remainder is the apparent time past noon of the preceding civil day. To the Apparent time, thus found, apply the Equation of time, and the result is the *Mean time* at the ship.

EXAMPLE I.

August 20, 1849, the following observations were made of the sun's lower limb, in latitude 41° 20′ N, and in longitude, by account, 142° W., the height of the observer's eye being 22 feet. Required the Mean time at the ship.

App. Times by Watch.	Obs. alts. of ⊙'s L. L.
5h 6′ 16″	18° 28′
7 15	18 11
8 17	17 55
9 14	17 40
10 18	17 26
5) 41 20	5) 89 40
Mean, 5h 8 16	17 56
Corr. (XVI.),	+ 9
True alt. of ⊙'s centre,	18 5

Preliminary Work. (See Note.)

App. time by watch,	5h	8′	16″	Eq. of time, Aug. 20,	+ 3′ 10″
Long. of ship, 142° W., by (XI.) =	9	28	0	Daily Var. 14″, decreasing, gives for 12h, (XIV.) — 7″ for 2h 36′, —2	— 9
App. time at Green.	14	36	16		
Equation of time,	+	3	1 *	Equation of time,	+ 3 1 *
Mean time at Green.	14	39	17	⊙'s dec., Aug. 20, decreasing,	12° 25′ 19″ N
				Corr., (XIII.), for 12h = — 10′ for 2h 39′ = — 2	— 12
				⊙'s declination,	12 13 N

Calculation of the Mean Time.

Latitude,	41°	20′ N.				
Declination,	12	13 N.				
1st Arc,	29	7	Half-cosine,	72′	48″	
2d Arc,	53	33	Half-cosine,	49	31	
True alt.,	18	5	Half-sine,	25	52	
			Sum,	2° 2	19	Prop. Log., 10·1678
			Difference,	46	56	Prop. Log., ·5838
			Meridian distance, = Apparent time,	5h 6′	13″	Log., 9·5840
			Equation of time,	+ 3	1	
			Mean time at ship,	5 9	14, on Aug. 20, 1849.	

Note. The Preliminary work may be varied as follows;—

Observed alt. of ⊙'s L. L.	17° 56′ 0″	⊙'s dec., Aug. 20,	12° 25′ 19″ N
Dip, (III.), — 4′ 30″		Do., Aug. 21,	12 5 23 N
Refraction, (IV.), — 2 55	— 7 25	Daily Var.	— 19 56 (XIX.), Log. 0806
	17 48 35	Time at Green.	14h 39′, Log. 2144
Parallax (III.), + 0′ 9″		Correction,	— 12′ 10″, Log. 2950
Semi-diameter, + 15 50	+ 15 59	⊙'s dec., Aug. 20,	12° 25 19 N
True alt. of ⊙'s centre,	18 4 34	⊙'s dec.,	12 13 9 N

Or, the correction of the sun's declination, for the time past noon, may be thus ascertained; the hourly variation at Page I. Naut. Alm., is 49″. 83 which multiplied by given time 14h 39′ or 14.65, gives 730″.0095 = 12′ 10″. The hourly variation of the Equation of time, at page I. Naut. Alm., is 0″. 593, which, multiplied by the given apparent time 14h 36′, or 14.6, gives 8″. 6578, or 9″.

EXAMPLE II.

April 14, 1849, the following observations were made of the sun's lower limb, in latitude 20° 14′ S, and longitude by account 162° E, the height of the observer's eye being 20 feet, and the index error of the sextant 1′ 15″ subtractive. Required the mean time at the ship.

App. Times by Watch.	Obs. alts. ⊙'s L. L.
19h 45′ 21″	20° 15′ 15″
44 19	20 0 15
43 20	19 45 15
3) 133 0	3) 60 0 45
Mean 19 44 20	20 0 15
Index Error,	— 1 15
	19 59
Corr., (XVI.),	+ 9
True alt., ⊙'s centre,	20 8

Preliminary Work.

App. time at ship,	19h	44′	20″
Long. 162° E (XI.), =	10	48	0
App. time at Green.	8	56	20
Equation of time,		+	9 *
Mean time at Green.	8	56	29

Eq. of time, April 14,	+ 0′ 15″
Daily Var. 15″, decreasing, gives for 8h 56′ or 9h, (XIV.),	— 6
Eq. of time,	+ 0 9 *
⊙'s dec., April 14, increasing,	9° 28′ N
Corr., (XIII.), for 9h	+ 8
⊙'s declination,	9 36 N

Calculation of the Mean Time.

Latitude,	20°	14′ S
Declination,	9	36 N
1st Arc,	29	50
2d Arc,	10	38
True alt.,	20	8

Half-cosine,	72′	17″			
Half-cosine,	81	54			
Half-sine,	28	41			
Sum,	2°	34	11	Prop. Log.	10.0672
Difference,	0	43	36	Prop. Log.	6158
Meridian distance,	4h	17′	0″	Log.	9.4514
	24h				
App. time at ship,	19	43	0		
Equat. of time,		+	9		
Mean time at ship,	19	43	9,	on April 14,	

EXAMPLE III.

June 4, 1849, the following observations were made of the sun's lower limb, in latitude 69° 15′ N, and longitude by account 52° W, the height of the observer's eye being 24 feet. Required the mean time at the ship.

App. Times by Watch.	Obs. alts. ⊙ s L. L.
5h 58′ 13″	21° 26′
5 59 15	21 10
6 0 17	20 54
3) 17 57 45	3) 63 30
Mean 5 59 15	21 10
Corr., XVI.,	+ 9
True alt. ⊙'s centre,	21 19

Preliminary Work.

App. time at ship,	5h	59′	15″
Long. 52° W, (XI.) =	3	28	0
App. time at Green.	9	27	15
Equation of time,	—	1	59 *
Mean time at Green.	9	25	16

Eq. of time, June 4,	— 2′ 3″
Daily Var. 10″, decreasing, gives for 9h 27′, (XIV.),	— 4
Eq. of time,	— 1 59 *
⊙'s dec., June 4, increasing,	22° 27′ N
Corr., (XIII.), for 9h,	+ 3
⊙'s declination,	22 30 N

Calculation of the Mean Time.

Latitude,	69°	15′ N
Declination,	22	30 N
1st Arc,	46	45
2d Arc,	91	45
True alt.,	21	19

Half-cosine,	57′	6″			
Half-cosine,	2	33			
Half-sine,	30	18			
Difference,	54	33		Prop. Log.	10.5185
Difference,	26	48		Prop. Log.	8271
Meridian Distance, = Apparent time at ship,	5h	56′	2″	Log.	9.6914
Equation of time,	—	1	59		
Mean time at ship,	5	54	3,	on June 4, 1849.	

Note 1. In the preceding examples, the Altitude, Declination, and Equation of time may be corrected by several methods, as is done in Note to Example I., page 8: at sea, however, it will be sufficiently accurate to correct these at once by inspection, as in Examples II. and III.

Note 2. The apparent time at the ship, nearly, will be shown by a watch set to XII. hours, when the sun's meridian altitude is taken. The change of longitude since noon, reduced to time, (by explanation of Table XI., page v.) must, however, be applied to the time shown by the watch, to find the apparent time at the ship: the change of longitude, when made to the eastward, must be added, but if to the westward, it must be subtracted. This method may be used when the chronometer is out of order; but, if not, it is always preferable to find the mean time at Greenwich by means of the chronometer, by Article 8, Sect. I., page 2.

ARTICLE II.

To find the Mean Time by an Altitude of a Fixed Star.

RULES.

1. Find the mean time at Greenwich as in the case of the Sun, page 7.

2. Take from the Nautical Almanac, the Star's Right Ascension, and Declination.

Note. These are found at Pages 456 to 458 in the Almanac for 1849, under the title "Mean places of 100 principal fixed stars."

3. Take out the Sun's Right Ascension for mean noon, from the Nautical Almanac, and correct it for Greenwich mean time by Table XII. Also take out the Equation of time, as in the case of the Sun, page 7.

Note. The correction of the Sun's Right Ascension for Greenwich mean time, may also be found by means of the daily variation of the Right Ascension and Table XIX.; see Explanation of this table, page vii.

4. Find the Star's true altitude, by subtracting the correction, found in Table XV., from the observed altitude.

5. From the Latitude of the Ship, the Star's declination, and the Star's true altitude, calculate the Star's meridian distance, as in the case of the Sun; see Rules in pages 7 and 8.

6. When the Star is *West* of the meridian, *add* its meridian distance to its Right Ascension; when the Star is to the *East* of the meridian, *subtract* its meridian distance from its Right Ascension, (increasing the latter by 24 hours, if necessary): the result is the Right Ascension of the meridian.

7. From the Right Ascension of the meridian, (increased by 24 hours, if necessary,) subtract the Sun's Right Ascension, the remainder is the apparent time at the ship: to which apply the Equation of time, and the result is the mean time at the ship.

EXAMPLE I.

July 15, 1849, the following altitudes were taken of the star Arcturus, then Westward of the meridian, in Latitude 42° 15′ N, and in Longitude, by account, 18° 20′ W: the height of the eye being 15 feet, and index error of the sextant + 1′ 50″. Required the mean time at the ship.

App. Times by Watch.	Obs. alts. of Star.
10h 45′ 10″	33° 18′
46 15	33 12
47 19	33 5
3) 138 44	3) 99 35
Mean, 10 46 15	33 12
Index error, + 2′ / Corr. (XV.), − 5	− 3
True altitude,	33 9

Preliminary Work.

App. time at ship,	10h	46′	15″
Long. 18° 20′ W = (by XI.),	1	13	20
App. time at Green.,	11	59	35
Equation of time,	+	5	38 *
Mean time at Green.,	12	5	13
R. A. of Arcturus,	14h	8′	46″
Dec. of do.	19	58′	N

Eq. of time, July 15,	+	5′	35″
Daily Var. 6″ increasing gives, for 12h (XIV),	+		3
Equat. of time,	+	5	38 *
⊙'s R. A., July 15,	7h	38′	28″
Corr. (XII.), for 12h	+	2	1
	7	40	29

Calculation of the Mean Time.

Latitude,	42° 15′ N
Declination,	19 58 N
1st Arc,	22 17
2d Arc,	62 13
True alt.,	33 9

Half-cosine,		77′	7″	
Half-cosine,		38	51	
Half-sine,		45	34	
Sum,	1	55	58	Prop. Log. 10.1909
Difference,		31	33	Prop. Log. 7563
Meridian distance,	4h	11′	30″ W,	Log. 9.4346
R. A. of Arcturus,	14	8	46	
R. A. of meridian,	18	20	16	
⊙'s R. A.,	7	40	29	
App. time at ship,	10	39	47	
Equation of time,	+	5	38	
Mean time at ship,	10	45	25	

EXAMPLE II.

January 20, 1849, the following altitudes were taken of the star Altair, then Eastward of the meridian, in Latitude 30° 5′ S, and in Longitude, by account, 32° 15′ W : the height of the eye being 16 feet, and the index error of the sextant — 1′ 20″. Required the mean time at the ship.

App. Times by Watch.	Obs. alts. of Star.
19h 45′ 5″	25° 21′
46 8	13
47 6	5
3) 138 19	3) 39
Mean, 19 46 6	25 13
Index error, − 1′ / Corr., (XV.), − 6	− 7
True Alt.,	25 6

Preliminary Work.

App. time at ship,	19h	46′	6″
Long. 32° 15′ W, = (by XI.)	2	9	0
App. time at Green.,	21	55	6
Equation of time,	+	11	39 *
Mean time at Green.,	22	6	45
R. A. of Altair,	19h	43′	25″
Dec. of do.	8°	28′	N

Eq. of time, Jan. 20,	+	11′	24″
Daily Var., 17″ increasing, gives for 22h (XIV.),	+		15
Equation of time,	+	11	39 *
⊙'s R. A., Jan. 20,	20h	10′	23″
Corr. (XII.), for 22h 6′,	+	3	55
⊙'s R. A.,	20	14	18

Calculation of the Mean Time.

Latitude,	30° 5′ S
Declination,	8 28 N
1st Arc,	38 33
2d Arc,	21 37
True alt.,	25 6

Half-cosine,		65′	10″	
Half-cosine,		77	28	
Half-sine,		35	21	
Sum,	2°	22	38	Prop. Log. 10.1011
Difference,		29	49	Prop. Log. 7808
Meridian distance,	3h	37′	40″ E,	Log. 9.3203
R. A. of Altair,	19	43	25	
	16	5	45	
⊙'s R. A.,	20	14	18	
App. time at ship,	19	51	27	
Equation of time,	+	11	39	
Mean time at ship,	20	3	6	

ARTICLE III.

To find the Mean Time by an Altitude of a Planet.

RULES.

1. Find the mean time at Greenwich, as in the case of the Sun.

2. Take from the Nautical Almanac, the Planet's Right Ascension, and Declination.

Note. These are found at pages 276 to 455, in the Nautical Almanac for 1849, for noon at Greenwich, and are reduced to what they should be at the given time, by means of the hourly variation, which is also given in the Almanac. To find the correction of the Right Ascension or Declination: multiply the hourly variation by the given time, expressed in hours and decimals of an hour, the result is to be added to, or subtracted from the Right Ascension, or Declination at noon, according as the hourly variation is increasing or diminishing, which is denoted in the Almanac by + or —. Or the same may be found by means of the Daily variation, and Table XIX.

Then proceed exactly as in the case of a Star, see Rules, 3, 4, 5, 6, and 7, page 10.

EXAMPLE.

July 20, 1849, the following altitudes were taken of the Planet Jupiter, then Westward of the meridian, in Latitude 34° 9′ S, and in Longitude, by account, 10° 20′ E: the height of the eye being 16 feet, and the index error of the sextant — 6′ 15″. Required the Mean time at the ship.

App. Times. by Watch.	Obs. alts. of Jupiter.
5h 58′ 35″	15° 17′
59 0	23
59 30	29
3)177 5	3) 69
Mean, 5 59 2	15 23
Index error,	— 6
	15 17
Corr., (XV.),	— 7
True alt.,	15 10

Preliminary Work.

App. time at ship,	5h	59′	2″
Long. 10° 20′ E, = (by XI.),	0	41	20
	5	17	42
Equation of time,	+	6	1 *
Mean time at Green.,	5	23	43
R. A. of Jupiter, July 20,	9h	51′	35″
Hourly Var., + 1.97″ × 5h		+	10
R. A. of Jupiter,	9	51	45
Dec. of Jupiter, July 20,	13°	55′	24″ N
Hourly Var., — 10.3″ × 5h		—	52
Dec. of Jupiter,	13	54	32 N

Eq. of time, July 20,	+	6′	0″
Daily Var., 3″, increasing, gives for 5h (XIV.),	+		1
Equation of time,	+	6	1 *
⊙'s R. A., July 20,	7h	58′	36″
Corr. for 5h 23′, (XII.),	+		53
⊙'s R. A.,	7	59	29

Calculation of the Mean Time.

Latitude,	34°	9′	S
Declination,	13	55	N
1st Arc,	48	4	
2d Arc,	20	14	
Altitude,	15	10	

Half-cosine,		55′	41″	
Half-cosine,		78	11	
Half-sine,		21	48	
Sum,	2	13	52	Prop. Log., 10.1286
Difference,		33	53	Prop. Log., 7253
Meridian distance,	4h	1′	38″ W,	Log. 9.4033
R. A. of Jupiter,	9	51	45	
R. A. of meridian,	13	53	23	
R. A. of the Sun,	7	59	29	
App. time at ship,	5	53	54	
Equation of time,	+	6	1	
Mean time at ship,	5	59	55	

ARTICLE IV.

To find the Mean Time by an Altitude of the Moon.

RULES.

1. Find the mean time at Greenwich, as in the case of the Sun.

2. Take from the Nautical Almanac, the Moon's Right Ascension, and Declination; and also the Moon's Horizontal Parallax, and Semi-diameter.

Note 1. The Moon's Right Ascension and Declination are given at pages v. to XII. of the Almanac, for every hour of Greenwich mean time. Hence, if they are taken out for the given hour of time, the corrections must be found for the remaining minutes and seconds of the given time. These corrections may be found by means of the hourly variations, and Table XXI. The correction of the Declination may also be found thus: take the difference for 10 minutes of time, as given in the Almanac, and remove the decimal point one place to the left, which will give the difference for 1 minute of time; then multiply this by the minutes and seconds of the given time expressed in minutes and decimals of a minute. These corrections are additive or subtractive, according as the quantities to which they have to be applied are increasing or diminishing.

Note 2. The Moon's Horizontal Parallax and Semi-diameter are given for noon and midnight of Greenwich mean time; at page III. of the Almanac. Take these out for noon, if the given mean time is less than 12 hours; but take them out for midnight, if the time exceeds 12 hours; and, at same time, note the variation of each for the next 12 hours. With the time past noon or midnight and the variations for 12 hours, find the corrections by Table XX., which are to be added or subtracted according as the variation is increasing or diminishing.

Then proceed exactly as in the case of a Star, Rules 3, 4, 5, 6, and 7, page 10, excepting Rule 4, for correcting the altitude, which for the Moon is done as follows:—

From the observed altitude, corrected for index error, subtract the Dip (III.), and Refraction (IV.), and to the remainder add the Moon's parallax in altitude, found thus: to the Proportional Logarithm (X.), of the Moon's Horizontal Parallax, add the Logarithmic Secant, (or Co-secant (IX.), of the complement) of the altitude, the sum is the Proportional Logarithm of the Parallax in altitude. To the altitude thus corrected, add the Moon's Semi-diameter, if the lower limb was observed; or, subtract it, if the Moon's upper limb was observed, the result is the true altitude of the Moon's centre.

EXAMPLE.

April 10, 1849, the following altitudes were taken of the Moon's upper limb, then Westward of the meridian, in Latitude 34° 40′ S., and Longitude by account, 50° W.: the height of the eye being 16 feet, and the index error of the sextant — 8′ 5″. Required the Mean time at the ship.

App. Times by Watch.	Obs. alts. of ☽'s U. L.
18h 20′ 5″	38° 5′
34	11
59	17
3) 98	3) 33
Mean, 18 20 33	38 11 0
Index error,	— 8 5
	38 2 55
Dip, (III.),	— 3 50
	37 59 5
Ref. (IV.),	— 1 13
	37 57 52
☽'s Par. in Alt.	+ 42 43†
	38 40 35
☽'s Semi-diam.,	— 14 46
True Alt. of ☽'s centre,	38 25 49

Preliminary Work.

App. time at ship,	18h 20′ 33″	
Long., 50° W, = (by XI.),	3 20 0	
	21 40 33	
Eq. of time,	+ 1 3 ✱	
Mean time at Green.,	21 41 36	
☽'s Semi-diam., midnight, April 10,	14′ 47″	
Var. for 12h, — 1″, gives, for 10h (XX.),	— 1	
☽'s Semi-diam.,	14 46	
☽'s Hor. Par. midnight, April 10,	54′ 16″	
Var. for 12h, — 5″, gives, for 10h (XX.),	— 4	
☽'s Hor. Par.,	54 12	

☽'s Hor. Par., 54′ 12″ P. L. 5213
☽'s Alt. 37 58′
Compt., 52 2 cosec. L. 1033
† ☽'s Par. in Alt., 42′ 43″ P. L. 6246

Eq. of time,	+ 1′ 18″
Var., 16″, diminishing, gives for 22h (XIV.),	+ 15
Equat. of time,	1 3 ✱
☉'s R. A., noon,	1h 15′ 42
Corr., for 21h 42′ (XII.),	+ 3 22
☉'s R. A.,	1 19 4
☽'s R. A., at 21h,	16h 7′ 25″
do. at 22h,	16 9 27
Hourly Var.,	+ 2 2
H. var., + 2′ 2″ Log. (XXI.),	1.4699
Time, 41′ 36″ Log.	1591
Corr., + 1 25″ Log.	1.6290
☽'s R. A., at 21h,	16h 7′ 25″
Corr., as above,	+ 1 25
☽'s R. A.,	16 8 50
☽'s Dec., at 21h,	15° 44′ 45″ S
Do., at 22h,	15 49 55 S
Hourly Var.,	+ 5 10
H. var., + 5′ 10″, Log. (XXI.),	1.0649
Time, 41′ 36″, Log.	1591
‡ Corr., + 3′ 35″, Log.	1.2240
☽'s Dec., at 21h,	15° 44′ 45″ S
Corr., as above,	+ 3 35
☽'s Declination,	15 48 20 S

The correction of the Moon's Declination, for 41′ 36″, may also be found thus:—

The Variation of the Declination for 10′ of time is + 51″. 75, which gives for 1′ of time, var., + 5″.175, and this being multiplied by 41′ 36″ = 41′.6, gives 215″.2800 = 3′ 35″ ‡

Calculation of the Mean Time.

Latitude,	34° 40′ S
Declination,	15 48 S
1st Arc,	18 52
2d Arc,	50 28
True alt.,	38 26

Half-cosine,	78′ 51″	
Half-cosine,	53 3	
Half-sine,	51 48	
Sum,	2° 11 54	Prop. Log. 10.1350
Difference,	27 3	Prop. Log. 8231
Meridian Distance,	3h 35′ 25″ W,	Log. 9.3119
☽'s R. A.,	16 8 50	
R. A. of Meridian,	19 44 15	
☉'s R. A.,	1 19 4	
	18 25 11	
Equation of time,	+ 1 3	
Mean time at ship,	18 26 14	

REMARKS.

1. As Altitudes taken at sea are liable to error, instead of observing one altitude for finding the time, it is proper to observe several altitudes, noting the times of each being taken by watch; then by adding the altitudes, and also the times, and dividing the sums by the number of them, the results will be a mean or average altitude and the corresponding time. An altitude thus found may be more depended on than any single altitude, as the errors of observation will thus be made to balance each other, at least in part. An odd number of altitudes, such as three or five, is taken, as being preferable to an even number.

2. The Altitude for finding the time should be taken as near as possible to the time the celestial body observed is on the prime vertical, that is, when it bears due East or due West from the observer. At the time referred to the change of altitude, in a given time, such as 1 minute, is quickest; and consequently any error committed in taking the altitude will cause the least error in the computed time. An error, also, in the Latitude of the ship will, when the body is on the prime vertical, affect the time found from the altitude then taken less than at any other time.

3. When the Declination and Latitude are of different names, the celestial body does not come to the prime vertical, while above the horizon. Consequently, as it will be due East before it rises, and due West after it sets, according to Remark 2 the altitudes ought to be taken as near as possible to the time of rising or setting. This would cause the least error in the time, as far as the error of the Latitude, and the error made in observing the Altitude are concerned; but there is a more important error to be avoided, viz., that arising from the uncertainty of the Refraction near the horizon, which renders it advisable not to take an altitude less than 10°, for finding the time.

4. In high Latitudes, it may be stated generally, as a sufficiently correct rule, that the Altitude should not be taken when the celestial body is nearer to the meridian than three hours; in low Latitudes, however, the time may often be found more correctly by an altitude taken within one hour of the meridian passage of the body, than at several hours from the meridian passage in high Latitudes.

5. The change of altitude for 1 minute of time may easily be found by taking two or more observations of the altitude, and noting the corresponding times; the difference of any two of the altitudes will be the change of altitude during the difference between the corresponding times, from which the change of altitude for 1 minute of time may easily be found by proportion. If the altitude changes 6′ in 1 minute of time, an error of 1′ in the altitude will give an error of 10 seconds in the time, which will be sufficiently accurate. But if the change of altitude for 1 minute of time is much less than 6′, the observation should not be relied on; as the change of altitude is too slow, which may arise from either of two causes; viz., either that the observation has been taken too near to the meridian passage of the body; or that the declination of the body is of a contrary name to the Latitude, and too large. In the former case, an observation should be taken when the body is nearer to the prime vertical; in the latter, the body itself must be rejected as an improper one for finding the time.

6. The time when a celestial body is on the prime vertical may be known, by noting when it bears due East or West by the Compass, allowing for variation; or the time and corresponding altitude may be computed by the following Rules.

I. *To find the Time when a celestial body is on the Prime vertical.*

RULES.

1. From the Logarithmic Tangent (IX.) of the Declination of the body, subtract the

Logarithmic Tangent (IX.) of the Latitude of the ship, (borrowing index 10., when necessary;) the remainder is the Logarithmic Sine of an arc, which may, therefore, be found in Table IX.

2. This arc being converted into time, by explanation of Table XI. page v., and subtracted from VI. hours, will give the time before or after the meridian passage of the body, when it is on the prime vertical.

3. As the Sun passes the meridian at noon, the time thus found will be the apparent time, P.M., when the Sun is due West; and if this is taken from 12 hours, the remainder is the apparent time, A.M., when the Sun is due East. Or, these times may be found by first subtracting from VI^h., and then adding to VI^h., the time corresponding to the arc found in Rule 1.

In the case of the celestial body of which the altitude is taken, being the Moon, a Planet, or a Fixed star, its meridian passage must be found by subtracting the Right Ascension of the Sun from that of the body (the latter being increased by 24 hours, if necessary): it will be sufficiently correct, for the present purpose, to take out the Right Ascensions from the Nautical Almanac for noon of the given day. To the time of the meridian passage, add the interval found by Rule 2, (rejecting 24 hours, if it exceed 24^h), the sum is the apparent time when the body is due West; and from the time of the meridian passage, (increased by 24 hours, if necessary), subtract the interval found by Rule 2, the remainder is the apparent time when the body is due East.

II. *To find the Altitude of a celestial body when on the Prime vertical.*

RULES.

1. From the Logarithmic Sine (IX.), of the Declination of the body subtract the Logarithmic Sine (IX.), of the Latitude of the ship, the remainder is the Logarithmic Sine (IX.), of the true Altitude of the centre of the body.

2. The corrections applied to the observed altitude to find the true altitude, must be applied in a contrary manner, when the observed altitude is to be deduced from the true altitude: thus, in the case of a star, instead of adding the correction taken from Table XV., as directed in Rule 4, page 10, it must be subtracted from the true altitude to find the observed altitude.

EXAMPLE.

When the Sun's declination is 15° N., and the Latitude of the ship 57° 9′ N., required the time when the sun will be on the prime vertical, and the Altitude which the sun's lower limb would then be observed to have, the height of the eye being 16 feet.

Declination,	15°,		Tan. Log.	9.4281	Declination,	15°,	Sine Log. 19.4130
Latitude,	57°	9′,	Tan. Log.	0.1900	Latitude,	57° 9′,	Sine Log. 9.9243
	9°	58′	Sine Log.	9.2381	True alt.,	17° 57′,	Sine Log. 9.4887
	×	4				— 9′, Corr. (XVI.)	
	0^h	39′	52″			17 48,	Obs. alt. of ⊙'s lower limb.
	6	0	0				
	5	20	8,	P.M., App. time, when Sun is due W.			
	6	39	52,	A.M., do., when Sun is due E.			

SECTION III.

ON FINDING THE LONGITUDE BY CHRONOMETERS.

RULES.

1. FIND the mean time at the ship by Section II.

2. To the time by the Chronometer when the altitude was taken, apply the error of the chronometer, and the accumulated rate, by Section I., Article 8, page 2, to find the mean time at Greenwich.

3. The difference between the mean time at the ship, and the mean time at Greenwich, will give the Longitude of the ship in time (see Section I., Article 2, page 1), which may be reduced into space by Explanation of Table XI., page v.

EXAMPLE I.

August 20, 1849, a Chronometer showed $14^h\ 18^m\ 49^s$, when the Sun's altitude was found as in Example I., page 8. Required the Longitude of the ship: the error of the Chronometer having been determined to be $10^m\ 44^s$ fast of Greenwich mean time, on June 15, 1849, and gaining $1^s.2$ daily.

Note. The time by Chronometer may be found, by noting the several times shown by it, when the altitudes are observed, and taking their mean. But, as it may be inconvenient to use the chronometer for this purpose, and as it would be improper to remove it from its place, it is sometimes necessary to note the times by watch; and, after taking their mean, the corresponding time by chronometer may be easily found, by subtracting from the mean of the times shown by the watch, the portion of time which the watch may be fast of the chronometer; or, by adding these, if the watch is slow of the chronometer.

Time by Chronometer,	14h	49m	18s		
Original error,	—	10	44		
	14	38	34		
Accumulated rate for 66 days at $1^s.2 = 79^s.2$	—	1	19		
Mean time at Greenwich,	14	37	15		
Mean time at ship,	5	9	14,		by Example I., page 8.
Longitude in time,	9	28	1	W	
	60				
	4) 568°	1′			
Longitude,	142°	0′	15″	W	

EXAMPLE II.

April 14, 1849, a Chronometer showed $8^h\ 57'\ 50''$, when the Sun's altitude was found as in Example II., page 9. Required the Longitude of the ship; the error of the Chronometer having been determined to be $3'\ 5''$ fast of Greenwich mean time, on March 2, 1849, and losing $2''.3$ daily.

Time by Chronometer,	8^h	$57'$	$50''$		
Original error,	—	3	5		
	8	54	45		
Accumulated rate, for 43 days at $2''.3 = 98''.9$,	+	1	39		
Mean time at Greenwich,	8	56	24		
Mean time at Ship,	19	43	9,		by Example II., page 9.
Longitude in time,	10	46	45	E	
	60				
	$4)\ 646^0$	$45'$			
Longitude,	161^0	$41'$	$15''$	E.	

EXAMPLE III.

June 4, 1849, a Chronometer showed $9^h\ 1'\ 40''$, when the Sun's altitude was found as in Example III., page 9. Required the Longitude of the ship, the error of the Chronometer having been determined to be $12'\ 4''$ slow of Greenwich mean time, on February 4, 1849, and losing $3''.4$ daily.

Time by Chronometer,	9^h	$1'$	$40''$		
Original error,	+	12	4		
	9	13	44		
Accumulated rate for 150 days at $3''.4 = 510''.0$,	+	8	30		
Mean time at Greenwich,	9	22	14		
Mean time at Ship,	5	54	3		
Longitude in time,	3	28	11	W.	
	60				
	$4)\ 208^0$	$11'$			
Longitude,	52^0	$2'$	$45''$	W.	

EXAMPLE IV.

July 15, 1849, a Chronometer showed $9^h\ 47'\ 5''$, when the altitude of the star Arcturus was found, as in Example I., page 11. Required the Longitude of the ship; the error of the Chronometer having been determined to be $2^h\ 15'\ 6''$ slow of Greenwich mean time, on March 5, 1849, and gaining $1''.6$ daily.

Time by Chronometer,	9^h	$47'$	$5''$		
Original error,	+2	15	6		
	12	2	11		
Accumulated rate for 132 days at $1''.6 = 211''.2$,	—	3	31		
Mean time at Greenwich,	11	58	40		
Mean time at Ship,	10	45	25		by Example I., page 11.
Longitude in time,	1	13	15	W.	
	60				
	$4)\ 73$	$15'$			
Longitude,	18^0	$18'$	$45''$	W.	

REMARKS

REGARDING THE ERROR AND RATE OF A CHRONOMETER.

1. The error and rate of the Chronometer have been supposed, in the preceding Examples, to be determined on shore before the sailing of the ship. This is generally done by comparing the Chronometer with a well regulated clock, whose error and rate are known: the latter error and rate are most correctly ascertained by means of a Transit instrument. As, however, a Chronometer does not preserve its rate uniform for any great length of time, its rate should be determined from time to time when opportunity offers.

2. The error of a Chronometer, from Greenwich mean time, can be ascertained at sea by means of certain observations of the heavenly bodies; see Section I., Articles 19 to 22, pages 4 and 5; but when the ship arrives at a place whose Longitude is accurately determined, advantage should be taken of this to find the error of the Chronometer, as follows.

3. To find the error of a Chronometer at a place whose Longitude is accurately known. Take altitudes of the sun, and find the mean time at the place, as in Section II., by Rules at pages 7 and 8, to which apply the Longitude of the place in time, to find the mean time at Greenwich; see Section I., Article 3, page 1. The difference between the time by the Chronometer, and the mean time at Greenwich, will give the error of the Chronometer.

Note. In taking altitudes on shore, the artificial horizon should be used, in which case double of the altitude will be observed, and there is no dip. Hence, to the observed altitude, apply the index error of the sextant, take half the result; from this subtract the Refraction (IV.), corrected for the heights of the barometer and thermometer (IV.*), and then add the parallax in altitude (III.); to this add the sun's semi-diameter, if the lower limb was observed, or subtract the semi-diameter, if the upper limb was observed: the result is the true altitude of the sun's centre.

EXAMPLE.

On June 14, 1849, altitudes of the sun were taken at Bombay, in Longitude 72° 53′ 26″ E: the mean of the times at which the altitudes were taken being 15h 4′ 32″ by Chronometer, and the calculated mean time at Bombay 15h 4′ 22″. Required the error of the Chronometer from Greenwich mean time.

Mean time at Bombay,	15h	4′	22″
Longitude, 72° 53′ 26″ = (XI.),	*4	51	33.7, E.
Mean time at Greenwich,	10	12	48.3
Time by Chronometer,	15	4	32
Chronometer, fast,	4	51	43.7

Long., 72° 53′ 26″ changed to 72′ 53″ 26‴ × 4

4h 51′ 33″ 44‴ = 4 51 33.7*

4. If the error of a Chronometer be again determined, as in Remark 3, at the same place, after an interval of some days, the rate will become known, by dividing the gain or loss of the Chronometer during the interval, by the number of days in the interval; see Article 7, page 2: if the first error is slow, and the second fast, the sum of these shows what the Chronometer has gained in the interval; but, if the first error is fast, and the second error slow, the sum of these shows the loss of the Chronometer during the interval. Although the Longitude of the place requires to be accurately known for determining the error of the Chronometer, this is not necessary for finding its rate; as it is evident that an error in the Longitude will affect the two errors of the Chronometer equally, and will not therefore alter the gain or loss. The rate may also be found by finding the errors of the Chronometer from the mean time at the place instead of Greenwich.

EXAMPLE.

On June 23, 1849, altitudes of the sun were taken at Bombay, in Longitude 72° 53′ 26″ E: the mean of the times at which the altitudes were taken being 3h 2′ 20″ by the same Chronometer as used in Example to Remark 3, and the calculated mean time at Bombay 3h 4′ 5″. Required the daily rate of the Chronometer.

Mean time at Bombay, June 23, at	3h	4′	5″	
Longitude, 72° 53′ 26″ = (XI.),	4	51	33.7 E	
Mean time at Greenwich, June 22, at	22	12	31.3	
Time by Chronometer, June 23, at	3	2	20	
Chronometer, fast, June 23,	4	49	48.7	
Chronometer, fast, June 14,	4	51	43.7,	by Remark 3.
Interval, 9 days)		1	55	gain.
Daily Rate of Chronometer,			12″.8	losing.

The interval not being exactly 9 days, this will affect the rate: the dates were,

June 23, at	3h	4′
and June 14, at	15	4
Interval, 8 days,	12h	

If 8d 12h give 1′ 55″, then 1 day gives 13″.5 losing, as the daily rate.

OTHERWISE.

Suppose that the Longitude of Bombay is assumed to be 72° 50′ E, required the rate of the Chronometer.

Mean time at Bombay, June 14, at	15h	4′	22″		Long., 72° 50′
Longitude, 72° 50′ = (XI.),	4	51	20	E	changed to
Mean time at Greenwich,	10	13	2		72′ 50″
Time by Chronometer,	15	4	32		4
Chronometer fast,	4	51	30		4h 51′ 20″

Again,

Mean time at Bombay,	June 23,	at	3h	4′	5″	
Longitude, 72° 50′ = (XI.),			4	51	20 E	
Mean time at Greenwich,	June 22,	at	22	12	45	
Time by Chronometer,	June 23,	at	3	2	20	
Chronometer fast,	June 23,		4	49	35	
Chronometer fast,	June 14,		4	51	30,	as above.
Interval, 9 days)				1	55,	losing.
Daily Rate of the Chronometer,					12″.8	losing.

OTHERWISE.

The rate may also be found by finding the errors of the Chronometer from mean time at Bombay.

Mean time at Bombay, June 14, at	15h	4′	22″	
Time by Chronometer,	15	4	32	
Chronometer fast of Bombay time,			10″	
Mean time at Bombay, June 23, at	3h	4′	5″	
Time by Chronometer,	3	2	20	
Error of Chronometer from Bombay time, June 23,		1	45	slow.
Do., June 14,			10	fast, as above.
Interval, 9 days)		1	55	
Daily Rate of the Chronometer,			12″·8	losing.

5. Although the Longitudes of two places may not be accurately determined, the difference of their Longitudes may be nearly correct. Hence, although the error of a Chronometer cannot be ascertained with accuracy at either of these places, by the method in Remark 3; the rate of the Chronometer may be found nearly correct by Remark 4. The time at the place which is to the Eastward of the other is fast of the time at the latter, by the difference of Longitude in time.

EXAMPLE.

May 25, 1849, at Aden, when the Chronometer used in Example to Remark 3, showed $4^h\ 55'\ 43''$, the mean time at Aden was found to be $3^h\ 0'\ 14''$ by altitudes of the Sun. Required the rate of the Chronometer, Bombay being $1^h\ 50'\ 57''$ E. in Longitude from Aden.

Mean time at Aden, May 25, at	3h	0′	14″			
Difference of Long. from Bombay,	1	50	57	E		
Mean time at Bombay,	4	51	11			
Time by Chronometer, May 25, at	4	55	43			
Error of Chronometer, May 25,		4	32		fast of Bombay time.	
Do., June 14,			10		fast, by Ex., Remark 3.	
Interval, 20 days)		4	22			
Daily rate of the Chronometer,			13″.1		losing.	

Note 1. If the error of a Chronometer is ascertained at a certain date at any place, from which the ship sails and again returns after a short interval, when the error is again found, it is evident that the sea rate of the Chronometer will thence be found by Remark 4.

Or, if the ship, instead of returning to the place left, arrives at another place whose difference of Longitude from the first place is known, the sea rate is determined as in Remark 5.

Note 2. If the error of a Chronometer is found for several successive days at the same place, and the rate computed as in Remark 4, the average error may be deduced, by reducing each error to the last date of observation, and then taking the average of the results.

Note 3. The altitudes should be taken as nearly as possible at the same time of each day, as this will not only give nearly an entire number of days in the interval between the observations, but the rate is found to be more accurate than when deduced from altitudes, some of which are taken in the forenoon and some in the afternoon.

EXAMPLE.

Suppose that the error of the Chronometer used in Examples to Remarks 3 and 4, had been ascertained on several days between June 14 and June 23 to be as follows, and the rate of the Chronometer 13″.5 losing, as in Example of Remark 4.

June 14,	at	15h,	error,	0′	10″.0	fast,	and	13″.5	×	8½	days	= 1′	54″.7,	gives	1′ 44″.7 slow.
15,	„	3h,	„	0	3 .5	„	„	13 .5	×	8	„	= 1	48 .0,	„	1 44 .5 „
16,	„	3h,	„	0	9 .9	slow,	„	13 .5	×	7	„	= 1	34 .5,	„	1 44 .4 „
18,	„	3h,	„	0	37 .1	„	„	13 .5	×	5	„	= 1	7 .5,	„	1 44 .6 „
20,	„	3h,	„	0	44 .4	„	„	13 .5	×	3	„	= 0	40 .5,	„	1 44 .9 „
21,	„	3h,	„	1	18 .0	„	„	13 .5	×	2	„	= 0	27 .0,	„	1 45 .0 „
23,	„	3h,	„	1	45 .0	„								„	1 45 .0 „
														7)	12 13 .1
															1 44 .7 slow.

Mean error on June 23, from Bombay time,

6. When there are several Chronometers on board they should be compared with each other every day at nearly the same time of the day, and the differences of the times shown by them noted, one of the Chronometers being taken as the standard. By applying these differences to the time shown by the standard Chronometer when altitudes are taken to ascertain the Longitude as at page 17, the corresponding time by the other Chronometers become known; and, hence, by applying to these the original errors and accumulated rates, the time at Greenwich is found, and the Longitude of the ship may therefore be deduced from each Chronometer, and the mean of them taken.

From these differences also the daily gain or loss of each Chronometer when compared with the others may be found, and hence their comparative regularity of going may be estimated. Hence, when there are several Chronometers at hand, the irregular motion of one of them may be detected; and this Chronometer would be rejected in finding an average Longitude from the Chronometers.

EXAMPLE.

Suppose three Chronometers, A, B, and C, are compared together about the same hour of each day, as in the following Table, and that the daily rate of A is 10″.4 gaining, of B = 8″.4 gaining, of C = 2″.4 losing.

Date.	1. Time by A	2. Time by B	3. Time by C	4. A fast of B	5. A fast of C	6. B fast of C	7. A gains on B	8. A gains on C	9. B gains on C
June 13	9h 0′ 0″	8h 57′ 49″.9	8h 55′ 47″.5	2′ 10″.1	4′ 12″.5	2′ 2″.4			
14	9 0 0	8 57 47 .7	8 55 34 .7	2 12 .3	4 25 .3	2 13 .0	2″.2	12″.8	10″.6
15	9 0 0	8 57 45 .5	8 55 21 .8	2 14 .5	4 38 .2	2 23 .7	2 .2	12 .9	10 .7
16	9 0 0	8 57 43 .3	8 55 8 .8	2 16 .7	4 51 .2	2 34 .5	2 .2	13 .0	10 .8
17	9 0 0	8 57 41 .0	8 54 56 .0	2 19 .0	5 4 .0	2 45 .0	2 .3	12 .8	10 .5
18	9 0 0	8 57 38 .7	8 54 43 .4	2 21 .3	5 16 .6	2 55 .3	2 .3	12 .6	10 .3

Daily gain of A =	10″.4	Daily gain of A =	10″.4	Daily gain of B =	8″.2
Daily gain of B =	8 .2	Daily loss of C =	2 .4	Daily loss of C =	2 .4
Daily gain of A on B =	2 .2	Daily gain of A on C =	12 .8	Daily gain of B on C =	10 .6

In the above Table, the times in column 2 subtracted from the times in column 1 give the times in column 4; in the same manner, from columns 1 and 3, we find the times in column 5; and from columns 2 and 3, the times in column 6. By subtracting each time in column 4 from the one below it, we find the quantities in column 7; and in the same manner, we find columns 8 and 9 from columns 5 and 6. From column 7, it appears that A is gaining on B almost uniformly the difference between their daily rates 2″.2, it may therefore be presumed that these Chronometers are both going steadily. Again, from columns 8 and 9, it appears that the comparative rates of C with A and B are nearly uniform and equal to the difference of the daily rates, or 12″·8 and 10″.6; consequently, Chronometer C may be presumed to be retaining its original rate nearly, although not going so steadily as A and B.

EXERCISES.

1. A Chronometer showed $0^h\ 20^m\ 33^s$, January 21, when the star Altair's altitude was found as in Example II., page 11. Required the Longitude of the ship, the error of the Chronometer having been determined to be $2^h\ 5^m\ 15^s$ fast of Greenwich mean time on December 1, 1848, at noon, and gaining $2^s.3$ daily.

Answer. Mean time at ship, January 20, 1849, at $20^h\ 3^m\ 6^s$; mean time at Greenwich, $22^h\ 13^m\ 21^s$; Longitude of ship, 32° 33′ 45″ W.

2. A Chronometer showed $6^h\ 21^m\ 31^s$, July 20, 1849, when the planet Jupiter's altitude was found as in Example, page 12. Required the Longitude of the ship, the error of the Chronometer having been determined to be $1^h\ 4^m\ 4^s.9$ fast of Greenwich mean time on June 5, 1849, at noon, and losing $1^s.5$ daily.

Answer. Mean time at ship, $5^h\ 59^m\ 55^s$; mean time at Greenwich, $5^h\ 18^m\ 34^s$; Longitude of the ship, 10° 20′ 15″ E.

3. A Chronometer showed $20^h\ 43^m\ 11^s.5$, April 10, 1849, when the Moon's altitude was found as in Example, page 13. Required the Longitude of the ship, the error of the Chronometer having been determined to be $1^h\ 2^m\ 3^s$ slow of Greenwich mean time on March 15, 1849, at noon, and losing $2^s.1$ daily.

Answer. Mean time at ship, $18^h\ 26^m\ 14^s$; mean time at Greenwich, $21^h\ 46^m\ 11^s$; Longitude of the ship, 49° 59′ 15″ W.

4. July 10, 1849, in Latitude 46° 42′ N., the altitude of the Sun's lower limb was observed to be 26° 29′, in the afternoon, when a Chronometer showed $3^h\ 49^m\ 14^s$. Required the Longitude of the ship, the error of the sextant being + 4′ 10″, the height of the observer's eye, 24 feet, and the error of the Chronometer, $1^h\ 3^m\ 4^s$ fast of Greenwich mean time, on June 20, at noon, and losing $4^s.8$ daily.

Answer. Mean time at ship, $5^h\ 1^m\ 46^s$; mean time at Greenwich, $2^h\ 47^m\ 46^s.6$; Longitude of the ship, 33° 22′ 21″ E.

Note. By the Nautical Almanac, the Sun's declination is 22° 14′ 28″ N., on July 10, and 22° 6′ 40″ N., on July 11. The equation of time is $4^m\ 58^s.05$ on July 10, and $5^m\ 6^s.3$ on July 11, additive to apparent time.

5. September 5, 1849, at noon, a Chronometer was $3^h\ 5^m\ 7^s.4$ fast of Greenwich mean time, and gaining $10^s.4$ daily.

November 2, 1849, in Latitude 36° 9′ S., the same Chronometer showed $4^h\ 45^m\ 3^s$, when the altitude of the Sun's lower limb was observed to be 25° 57′, in the afternoon. Required the Longitude of the ship: the index error of the sextant being + 3′ 10″, and the height of the observer's eye 22 feet.

Answer. Mean time at ship, $4^h\ 19^m\ 38^s$; mean time at Greenwich, $1^h\ 29^m\ 51^s.7$; Longitude of ship, 42° 26′ 35″ E.

Note. By the Nautical Almanac, the Sun's declination is 14° 49′ 13″ S., on November 2, and 15° 8′ 4″ S., on November 3. The equation of time is $16^m\ 16^s.50$, on November 2, and $16^m\ 16^s.57$ on November 3, subtractive from apparent time.

6. June 20, 1849, at noon, a Chronometer was $20^m\ 15^s$ fast of Greenwich mean time; and on July 3, at noon, it was $18^m\ 26^s$ fast.

July 20, civil time, in Latitude 39° 40′ N., the altitude of the Sun's lower limb was observed to be 32° 15′, in the forenoon, when the same Chronometer showed $6^h\ 1^m\ 5^s$, P. M. Required the Longitude of the ship; the index error of the sextant being — 3′ 5″, and the height of the observer's eye 24 feet.

Answer. The daily rate of the Chronometer was $8^s.4$ losing; the mean time at the ship, $19^h\ 48^m\ 11^s$ on July 19; mean time at Greenwich, $5^h\ 45^m\ 4^s$ on July 20; Longitude of the ship, 149° 13′ 15″ W.

Note. By the Nautical Almanac, the Sun's declination is 20° 39′ 41″ N. on July 20, and 20° 28′ 13″ N. on July 21. The equation of time is $5^m\ 59^s.82$ on July 20, and $6^m\ 3^s.19$ on July 21, additive to apparent time.

7. December 1, 1848, at noon, a Chronometer was $0^h\ 2^m\ 3^s.4$ fast of Greenwich mean time; and on December 20, it was $0^h\ 1^m\ 2^s$ slow.

January 25, 1849, in Latitude 31° 15′ N., the altitude of the Sun's lower limb was observed to be 18° 9′, in the afternoon, when the Chronometer showed $16^h\ 2^m\ 4^s$, January 24. Required the Longitude: the index error of the sextant being + 2′ 10″, and the height of the eye 22 feet.

Answer. The daily rate of the Chronometer was $9^s.8$ losing; the mean time at the ship, $3^h\ 45^m\ 41^s$ on January 25; the mean time at Greenwich, $16^h\ 8^m\ 55^s.5$ on January 24; and the Longitude of the ship, 174° 11′ 23″ E.

Note. By the Nautical Almanac, the Sun's declination is 19° 9′ 29″ on January 24, and 18° 54′ 45″ on January 25. The equation of time is $12^m\ 27^s.8$ on January 24, and $12^m\ 41^s.8$ on January 25, additive to apparent time.

8. January 2, 1849, at noon, a Chronometer was $18^m\ 40^s.5$ fast of mean time at Paramatta, in Longitude 151° 1′ E.; and January 13, at noon, it was $19^m\ 30^s.5$ fast, at the same meridian.

February 20, 1849, in Latitude 25° 19′ S., the altitude of the star Arcturus was observed to be 16° 18′ East of the meridian, when the above Chronometer showed $7^h\ 58^m\ 17^s$ on February 21. Required the Longitude: the index error of the sextant being — 4′ 10″, and the height of the eye 22 feet.

Answer. The daily rate of the Chronometer was $4^s.5$ gaining; the mean time at the ship, $12^h\ 3^m\ 35^s$ on February 20; the mean time at Greenwich, $21^h\ 31^m\ 47^s.5$ on February 20; and the Longitude of the ship, 142° 3′ 7″ W.

Note. By the Nautical Almanac, the R. A. of Arcturus is $14^h\ 8^m\ 46^s$, and the declination is 19° 58′ 15″ N. On February 20, the R. A. of the Sun is $22^h\ 15^m\ 12^s.47$, and on February 21, it is $22^h\ 19^m\ 2^s.03$; and the equation of time is $13^m\ 59^s.65$ on February 20, and $13^m\ 52^s.64$ on February 21, additive to apparent time.

9. June 20, 1849, at noon, a Chronometer was $2^m\ 47^s$ fast of Greenwich mean time, and losing $10^s.2$ daily.

July 10, 1849, in Latitude 26° 19′ N., the altitude of the centre of the planet Mars was observed to be 30° 54′ West of the meridian, when the above Chronometer showed $1^h\ 15^m\ 5^s$ on July 11. Required the Longitude: the index error of the sextant being + 2′ 5″, and the height of the observer's eye 22 feet.

Answer. The mean time at ship, $23^h\ 21^m\ 19^s$ on July 10; the mean time at Greenwich, $1^h\ 15^m\ 53^s$ on July 11; and the Longitude of the ship, 28° 38′ 30″ W.

Note. By the Nautical Almanac, the R. A. of Mars is $2^h\ 30^m\ 46^s.03$ on July 11, and $2^h\ 33^m\ 28^s.15$ on July 12; and the declination of the planet is 13° 18′ 8″.8 N. on July 11, and 13° 31′ 35″.7 N. on July 12. The R. A. of the Sun is $7^h\ 22^m\ 13^s.19$ on July 11, and $7^h\ 26^m\ 17^s.58$ on July 12; and the equation of time is $5^m\ 6^s.30$ on July 11, and $5^m\ 14^s.14$ on July 12, additive to apparent time.

10. February 5, 1849, at noon, a Chronometer was slow $1^h\ 2^m\ 3^s$ of Greenwich mean time, and gaining $4^s.2$ daily.

May 13, 1849, in Latitude 34° 9′ S., the altitude of the Moon's upper limb was observed to be 30° 1′, East of the meridian, when the above Chronometer showed $1^h\ 30^m\ 5^s$. Required the Longitude of the ship: the index error of the sextant being + 4′ 10″, and the height of the observer's eye 24 feet.

Answer. The mean time at the ship, $12^h\ 32^m\ 24^s$; the mean time at Greenwich, $2^h\ 25^m\ 20^s$; and the Longitude of the ship, 151° 46′ E.

Note. By the Nautical Almanac, on May 13, the R. A. of the Moon is $20^h\ 12^m\ 28^s.04$ at 2h, and $20^h\ 14^m\ 33^s.24$ at 3h; and the declination is 16° 49′ 57″.2 S. at 2h, and 16° 45′ 24″.0 S at 3h. On May 13, at noon, the semi-diameter of the Moon is 14′ 56″.2, and at midnight it is 15′ 0″.4; the Moon's horizontal parallax is 54′ 48″.7 at noon, and 55′ 4″.1 at midnight. On May 13, the R. A. of the Sun is $3^h\ 20^m\ 35^s.37$, and on May 14 it is $3^h\ 24^m\ 31^s.42$; and the equation of time is $3^m\ 54^s.70$ on May 13, and $3^m\ 55^s.21$ on May 14, subtractive from apparent time.

11. At Paramatta, in Latitude 33° 48′ 42″ S., and Longitude 151° 1′ E., on October 20, 1849, at $4^h\ 8^m\ 5^s$ apparent time by watch, the double altitude of the Sun's lower limb was observed to be 49° 34′ 20″, by an artificial horizon, when a Chronometer showed $2^h\ 9^m\ 3^s$. And on October 31, at $4^h\ 10^m\ 4^s$ apparent time by watch, the double altitude of the Sun's lower limb was observed to be 53° 30′ 10″, when the same Chronometer showed $2^h\ 11^m\ 5^s$. Required the daily rate of the Chronometer, and its error compared with Greenwich mean time when the latter altitude was taken: the error of the sextant being — 2′ 10″.

Answer. The mean time at the ship was $4^h\ 11^m\ 49^s$ on October 20, and $4^h\ 10^m\ 54^s$ on October 31. The Chronometer was $8^h\ 1^m\ 18^s$ fast of Greenwich mean time on October 20, and $8^h\ 4^m\ 15^s$ fast on October 31; and its daily rate $16^s.1$ gaining.

Note. By the Nautical Almanac, the declination of the Sun is 10° 3′ 1″.8 S. on October 19, and 10° 24′ 39″.2 S. on October 20; and the equation of time is $14^m\ 56^s.12$ on October 19, and $15^m\ 6^s.34$ on October 20, subtractive from apparent time. Also, the Sun's declination is 13° 51′ 15″.4 S. on October 30, and 14° 10′ 48″.4 S. on October 31; and the equation of time is $16^m\ 11^s.45$ on October 30, and $16^m\ 13^s.93$ on October 31, subtractive from apparent time.

12. June 5, 1849, at Falmouth, in Latitude 50° 8′ 50″ N., and Longitude 5° 2′ 45″ W., at $19^h\ 20^m\ 5^s$ apparent time by watch, the double altitude of the Sun's lower limb, taken by an artificial horizon was found to be 59° 29′ 30″, when a Chronometer showed $10^h\ 9^m\ 4^s$.

On June 18, 1849, at Funchal, in Latitude 32° 37′ 40″ N., and Longitude 16° 54′ 55″ W., at $20^h\ 52^m\ 6^s$ apparent time by watch, the double altitude of the Sun's lower limb was found to be 94° 28′ 50″, when the same Chronometer showed $12^h\ 29^m\ 40^s$. Required the rate of the Chronometer, and the error from Greenwich mean time when the latter altitude was taken: the error of the sextant being + 3′ 10″.

Answer. On June 5, the mean time at Falmouth was $19^h\ 19^m\ 16^s$; and Chronometer, $9^h 30^m 23^s$ slow of Greenwich mean time. On June 18, the mean time at Funchal was $20^h\ 51^m\ 17^s$, and the Chronometer, $9^h\ 29^m\ 17^s$ slow. The daily rate of the Chronometer was $5^s.1$ losing.

Note. By the Nautical Almanac, the Sun's declination is $22^0\ 34'\ 15''.7$ N., on June 5, and $22^0\ 40'\ 37''.0$ N., on June 6; and the equation of time is $1^m\ 52^s.67$, on June 5, and $1^m\ 42^s.19$, on June 6, subtractive from apparent time. The Sun's declination is $23^0\ 25'\ 24''.1$ N., on June 18, and $23^0\ 26'\ 28''.4$ N., on June 19; and the equation of time is $0^m\ 42^s.93$, on June 18, and $0^m\ 55^s.99$, on June 19, additive to apparent time.

SECTION IV.

ON FINDING THE LONGITUDE BY LUNAR DISTANCES.

In this method for finding the Longitude, the observer takes the distance between the nearest limbs of the Sun and Moon, or between the enlightened limb of the Moon and a Planet or Fixed Star, while other observers note the time by watch, and take the altitudes of the bodies. It is conducive to accuracy to take several observations, as in the case of altitudes, see Remark 1, page 15, and to find their mean.

The general principle on which this method is founded has been explained in Article 22 of Section I., page 5; we must, therefore, as there stated, proceed first to find the True distance from the given observed distance.

ARTICLE I.

To find the True distance between the centres of the Moon, and Sun, or a Planet, or a Fixed star.

PRELIMINARY RULES.

1. Find the mean time at Greenwich nearly, as in Preliminary Rule 1, Section I., page 7.

2. To find the elements from the Nautical Almanac. From page III. of the Almanac, take out the horizontal parallax and semi-diameter of the Moon, for noon or midnight, according as the mean time at Greenwich is less or greater than 12 hours, and note the variation of these for 12 hours; then correct them for the number of hours the given time is past noon or midnight, by Table XX.: the correction taken from this Table being additive or subtractive, according as the variation in 12 hours is increasing or diminishing. To the semi-diameter of the Moon, add the Augmentation, taken from Table III., which will give the semi-diameter at the given altitude.

If the Sun is observed, take the semi-diameter from page II. of the Nautical Almanac; and, if a Planet is observed, take out its horizontal parallax from the proper page of the Nautical Almanac.

3. To find the apparent altitudes: from the observed altitude, corrected for index error, subtract the Dip (III.), the remainder is the apparent altitude of the Planet or Star; but, for the Sun or Moon, add to this remainder, or subtract from it, the semi-diameter, according as the altitude of the lower or upper limb was observed: the result is the apparent altitude of the centre.

4. To find the apparent distance between the centres of the bodies: for the Sun and Moon (their nearest limbs being always observed), to the observed distance, add the semi-diameter of the Sun, and the augmented semi-diameter of the Moon; but, for the Moon and a Star or a Planet, to the observed distance add, or from it subtract, the Moon's augmented semi-diameter, according as the distance from the Moon's near or remote limb was observed: the result thus obtained is the apparent distance between the centres of the bodies.

Note. When a planet is observed, the distance should, properly, be taken from one of its limbs, and the semi-diameter of the planet should then be applied as in the case of the Sun; but it is more convenient in practice to take the distance from the centre of the planet.

RULES.

To find the Correction arising from Refraction.

1. Enter Table V., with the less apparent altitude at the top, and the greater apparent altitude in the side column, and find the corresponding *Auxiliary Arc* from the Table; see Explanation of this Table, pages ii. and iii.

2. Enter Table VI., with this *Auxiliary Arc* in the side column, and the Apparent distance at the top, and find the *first correction* or *correction for Refraction* from the Table: see explanation of this Table, pages iii. and iv. This correction is to be added to the Apparent distance, to obtain the *distance corrected for Refraction.*

To find the Correction arising from the Moon's Parallax.

3. Find the Departure of the Moon in altitude, by Table I., and add it to the apparent altitude. For the Sun, Star, or Planet, take the Refraction from Table IV., and subtract it from the apparent altitude. The results thus obtained are the *corrected altitudes.*

4. In the first line: write the Logarithmic Sine, and Logarithmic Tangent of the Distance corrected for Refraction, (Table IX.)

5. In the second line: write the Logarithmic Cosecant of the *corrected altitude* of the Sun, Star, or Planet, and the Logarithmic Cosecant of the *corrected altitude* of the Moon, (Table IX.)

6. In the third line: write in both columns, the Proportional Logarithm of the Moon's horizontal parallax, (Table X.)

7. Find the sums of the two columns thus formed, (rejecting 10 from the index of the first), and the results will be respectively the Proportional Logarithms of the *first arc*, and *second arc* of the *Departure* of distance. The *first arc* is always *West:* the *second arc* is *East*, when the distance is *less than* 90°; and *West*, when the distance is *greater than* 90°.

8. Find the amount of the *first* and *second arcs*, attending to their names as in Traverse Sailing: that is, add them, if they are of the same name, and make the sum of the common name; but, take their difference, if they are of contrary names, and make the difference of the same name as the greater arc. The result thus obtained is the *Departure of Distance*, or the *correction of distance for the Moon's parallax:* this must be corrected by applying to it the correction from Table VIII., which is *always West.*

9. The Departure of distance, thus found, if *East*, is to be *added* to the distance corrected for Refraction, found by Rule 2; but *subtracted* from it, if *West:* the result is the *True Distance.*

Note. It may be observed that all the quantities found by the preceding Rules are *West*, except when the *distance is less than* 90°; in which case, the *second arc* of departure is *East*, which may make the *departure of distance* also *East.*

To find the Correction arising from the Parallax of the Sun or a Planet.

10. The *correction for the Sun's parallax* is found, by inspection from Table VII., see Explanation of this Table, page iv. This correction is to be *added* to the *Apparent distance*, along with the Correction for Refraction found in Rule 2; but 10″ must be added to the correction for Departure of distance, found by Table VIII., as in the last part of Rule 8.

11. *The Correction for a Planet's parallax* is found by taking the correction, as in the case of the Sun, from Table VII., and multiplying it by the Planet's horizontal parallax, rejecting the last figure of the product. The correction thus found is to be *added* to the apparent distance, and the Planet's horizontal parallax must also be *added* to the correction for Departure of distance, as in the case of the Sun.

EXAMPLE I.

The apparent distance between the Moon's centre and a Star was found to be 99° 33′ 14″, the Moon's apparent altitude, 26° 23′, the Star's apparent altitude, 48° 16′, and the Moon's horizontal parallax, 56′ 30″. Required the true distance.

Apparent Distance,	99°	33′	14″
Aux. arc. (V.), = 16″, gives 1st corr. (VI.),	+	2	51
Corrected Distance,	99	36	5
☽'s Corrected alt.,	48°	15′	
☽'s Hor. par.,		56′	30″
1st Arc,		42′	45″ W.,
2d Arc,		4	18 W.
Departure of Distance,		47	3 W.
Corr. for Dep. 47′ (VIII.),			17 W.
		47	20 W.
Corrected Distance,	99°	36	5
True Distance,	98	48	45

☽'s App. alt.,	26°	23′	✳'s App. alt.,	48°	16′
Departure (I.),	+	23	Ref. (IV.),	—	1
☽'s Corrected alt.,	26	46	✳'s Corrected alt.,	48	15
Log. Sine,	9.9939			Log. Tan.	7718
Log. Cosec.	1272		☽'s Corr. alt. 26° 46′ Log. Cosec.		3464
P. L.	5032			P. L.	5032
P. L.	6243		2d Arc, 4′ 18″ W.,	P. L.	1.6214

EXAMPLE II.

The Apparent distance between the centres of the Sun and Moon was found to be 79° 59′ 54″, the apparent altitude of the Sun, 32° 59′, the apparent altitude of the Moon, 65° 35′, and the Moon's horizontal parallax, 57′ 20″. Required the true distance.

Apparent Distance,	79°	59′	54″		☽'s App. alt.,	65° 35′	⊙'s App. alt.,	32° 59′
Aux. arc (V.), = 15″, gives 1st Corr. (VI.),	+	2	11		Departure (I.),	+ 11	Ref. (IV.),	— 1
					☽'s Corrected alt.,	65 46	⊙'s Corrected alt.,	32 58
⊙'s Corr. (VII.),		+	2					
Corrected Distance,	80	2	7		Log. Sine, 9.9934			Log. Tan. 7552
⊙'s Corrected alt.,	32°	58′			Log. Cosec. 2643		☽'s Corr. alt., 65° 46′	Log. Cosec. 0401
☽'s Hor. par.,		57′	20″		P. L. 4969			P. L. 4969
1st Arc,		31′	40″	W.	P. L. 7546		2d Arc, 9′ 11″ E.,	P. L. 1.2922
2d Arc,		9	11	E.				
Departure of Distance,		22	29	W.				
10″ + Corr. for Dep. 22′ (VIII.),			31	W.				
		23	0	W.				
Corrected Distance,	80°	2	7					
True Distance,	79	39	7					

EXAMPLE III.

June 25, 1849, in Latitude 14° 50′ N., and Longitude by account, 45° 40′ W., the following sets of altitudes, and distances between the nearest limbs of the Sun and Moon, were observed: the times being noted from a watch showing apparent time at the ship nearly, the height of the observer's eye being 22 feet, and the index errors of the instruments as undernoted. Required the true distance between the centres of the Sun and Moon.

Times by Watch.	Obs. alts., ⊙'s L. L.	Obs. alts., ☽'s L. L.	Obs. Distances.
5h 18m 10s	15° 15′	78° 1′	70° 8′ 35″
20 3	14 49	77 38	9 40
21 47	14 20	77 12	10 30
3) 60 0	3) 44 24	3) 232 51	3) 28 45
Means, 5 20 0	14 48	77 37	70 9 35
	Index errors, — 2	+ 3	— 1 5
	14 46	77 40	70 8 30

Preliminary Work.

Time by Watch,	5h	20m	0s	☽'s S. D., noon,	15′	46″	☽'s Hor. par., noon,	57′ 50″
Long. 45° 40′ W = by (XI.),	3	2	40	Var. in 12h = — 8″, gives for 8h (XX.),	—	5	Var. in 12h = — 28″, gives for 8h (XX.),	— 19
App. time at Green.,	8	22	40		15	41		57 31
Eq. of time, noon,	+	2	14	⊙'s S. D., noon,	15	45		
Mean time at Green.,	8	24	54	Daily Var. = 0″, gives for 8h (XIV.),		0		
					15	45		

Calculation of the True Distance.

Observed Dist.,		70°	8′	30″	Obs. alt. ☽'s L. L.,		77°	40′	Obs. alt. ☉'s L.L.,	14° 46′
☉'s S. D.,		+	15	45	☽'s S. D.,	+ 15′ 56″			☉'s S. D., + 15′ 45″	
☽'s S. D.,		+	15	41	Dip (III.),	— 4 30	+	11	Dip (III.), — 4 30	+ 11
Aug. (III.),		+		15	☽'s App. alt.,		77	51	☉'s App. alt.,	14 57
Apparent Dist.,		70	40	11	Dep. (I.),		+	6	Ref. (IV.),	— 4
Aux. arc (V.), = 115″,					☽'s Corr. alt.,		77	57	☉'s Corr. alt.,	14 53
gives (VI.), for										
100″ =	1′ 46″									
15 =	1 57	+	3	43						
☉'s Corr. (VII.),		+		0						
Corrected Dist.,		70	43	54	Sine,	9.9750				Tan. 4565
☉'s Corr. alt.,		14°	53′		Cosec.	5903			☽'s Corr. alt., 77° 57′	Cosec. 0097
☽'s Hor. par.			57′	31″	P. L.	4955				P. L. 4955
1st arc,			15′	39″ W.	P. L.	1.0608			2d arc, 19′ 39″ E.,	P. L. 9617
2d arc,			19	39 E.						
			4	0 E.						
10″ + Corr. for Dep. 4′ (VIII.),				30 W.						
Departure of Dist.,			3	30 E.						
Corrected Dist.,		70°	43	54						
True Distance,		70	47	24						

EXAMPLE IV.

August 2, 1849, in Latitude 20° 5′ N., and Longitude, by account, 127° 10′ E., the following sets of altitudes, and distances between the Star α Arietis and the Moon's nearest limb, were observed: the times being noted from a watch, showing apparent time at the ship nearly, the height of the observer's eye being 22 feet, and the index errors of the instruments as undernoted. Required the true distance between the Star and Moon's centre.

Times by Watch.	Obs. alts., of ✳.	Obs. alts. of ☽'s U. L.	Obs. Distances.
11h 29m 5s	10° 59′	50° 38′	102° 22′ 20″
30 35	40	31	21 35
32 11	21	24	20 50
3) 91 51	3) 120	3) 93	3) 64 45
Means, 11 30 37	10 40	50 31	102 21 35
Index errors,	— 2	+ 3	— 1 5
	10 38	50 34	102 20 30.

Preliminary Work.

Time by Watch,	11h	30m	37s	☽'s S. D., noon,		14′	52″	☽'s Hor. par., noon,	54′ 32″
Long. 127° 10′ E. = by (XI.),	8	28	40	Var. in 12h = + 2″, gives for 3h (XX.),	+	0		Var. in 12h = + 10″, gives for 3h (XX.),	+ 2
App. time at Green.,	3	1	57			14	52		54 34
Eq. of time, noon,	+	5	57						
Mean time at Green.,	3	7	54						

Calculation of the True Distance.

Observed Dist.,			102°	20′	30″	Obs. alt. ☽'s U. L.,		50° 34′	☀'s Obs. alt.,	10° 38′
☽'s S. D.,	14′	52″				☽'s S. D.,	— 14′ 52″		Dip. (III.),	— 5
Aug. (III.),		12		— 15	4	Dip (III.),	— 4 30	— 19	☀'s App. alt.,	10 33
Apparent Dist.,			102	5	26	☽'s App. alt.,		50 15	Ref. (IV.),	— 5
Aux. arc (V.), = 135″,						Dep. (I.),		+ 17	☀'s Corr. alt.,	10 28
gives (VI.), for						☽'s Corr. alt.,		50 32		
100″	=	1′ 42″								
35	=	3 17								
135				+ 4	59					
Corrected Dist.,			102	10	25	Sine,	9.9901			Tan. 6664
☀'s Corr. alt.,			10°	28′		Cosec.	7407		☽'s Corr. alt., 50° 32′	Cosec. 1124
☽'s Hor. par.,				54′	34″	P. L.	5184			P. L. 5184
		1st arc,		10′	8″ W.	P. L.	1.2492		2d arc, 9′ 5″ W.,	P. L. 1.2972
		2d arc,		9	5 W.					
				19	13 W.					
Corr. (VIII.),					19 W.					
Departure of Dist.,				19	32 W.					
Corrected Dist.,			102°	10	25					
True Distance,			101	50	53					

EXAMPLE V.

June 28, 1849, in Latitude 10° 15′ N., and Longitude, by account, 66° 45′ E., the following sets of altitudes, and distances between the centre of the planet Jupiter and nearest limb of the Moon, were observed: the times being noted from a watch showing apparent time at the ship nearly, the height of the observer's eye being 22 feet, and the errors of the instruments as undernoted. Required the true distance between the centres of Jupiter and the Moon.

Times by watch.	Obs. alts. Jup.	Obs. alts. ☽'s L. L.	Obs. Dists.
7h 56m 3s	18° 55′	74° 36′	59° 2′ 25″
57 35	34	33	3 10
59 5	13	30	3 55
3) 172 43	3) 102	3) 99	3) 9 30
Means, 7 57 34	18 34	74 33	59 3 10
Index errors,	— 2	+ 3	— 1 5
	18 32	74 36	59 2 5

Preliminary Work.

Time by watch,	7h 57m 34s	☽'s S. D., noon,	15′ 6″	☽'s Hor. par., noon,	55′ 24″
Long., 66° 45′ E. = by (XI.),	4 27 0	Var. in 12h = — 5″ gives for 3h (XX.),	— 1	Var. in 12h = — 18″, gives for 3h (XX.),	— 4
App. time at Green.,	3 30 34		15 5		55 20
Equat. of time, noon,	+ 2 52			Jupiter's Hor. par.,	1″
Mean time at Green.,	3 33 26				

Calculation of the True Distance.

Observed Dist.,	59°	2′	5″	Obs. alt. ☽'s L. L.,			74°	36′	Jupiter's Obs. alt.,	18° 32′
☽'s S. D.,	+	15	5	☽'s S. D.,	+	15′	5″		Dip (III.),	— 5
Aug. (III.),		+	15	Dip (III.),	—	4	30	+ 11	Jupiter's App. alt.,	18 27
Apparent Dist.,	59	17	25	☽'s App. alt.,				74 47	Ref. (IV.),	— 3
Aux. arc. (V.), = 77″				Dep. (I.),				+ 7	Jupiter's Corr. alt.,	18 24
gives (VI.), for ′				☽'s Corr. alt.,				74 54		
70″ = 1′ 22″										
7 = 1 33	+	2	55							
⊙'s Corr. (VII.) = 1″ × 1 / ,1″			0							
Corrected Dist.,	59	20	20	Sine,	9.9346					Tan. 2270
Jupiter's Corr. alt.,	18°	24′		Cosec.	5008				☽'s Corr. alt., 74° 54′	Cosec. 0153
☽'s Hor. par.,		55′	20″	P. L.	5123					P. L. 5123
1st arc,		20′	18″ W.,	P. L.	9477				2d arc, 31′ 40″ E.,	P. L. 7546
2d arc,		31	40 E.							
		11	22 E.							
1″ + Corr. (VIII.),			22 W.							
Departure of Dist.,		11	0 E.							
Corrected Dist.,	59°	20	20							
True Distance,	59	31	20							

Remark 1. Instead of employing assistants to take the altitudes, the observer may, as in the following example, first take the altitude of the body nearest the meridian, then the altitude of the other body, and then an odd number of distances, concluding with taking altitudes in the reverse of the order commenced with. After finding the mean of the distances, and of the corresponding times, the altitudes for this time may be easily computed by proportion, as the change of altitude may be reckoned to be proportional to the change of time. The altitude of the body nearest the meridian is first taken, as its altitude will change uniformly during a longer interval than that of the other body.

EXAMPLE VI.

January 15, 1849, in Latitude 20° 5′ S., and Longitude, by account, 149° 40′ W., the following altitudes, and distances between the nearest limbs of the Sun and Moon, were observed: the times being noted from a watch showing apparent time at the ship nearly, the height of the observer's eye being 22 feet, and the errors of the instruments as undernoted. Required the true distance between the centres of the Sun and Moon.

Times by Watch.						
	19h	57m	43s	Alt. of ☽'s L. L.,	60°	53′
	19	58	50	Alt. of ☉'s L. L.,	34	20
	19	59	54	Distance,	84	46 25″
	20	1	5	"	84	46 55
	20	2	15	"	84	47 25
3)	60	3	14	" 3)	140	45
Means,	20	1	5	"	84	46 55
	20	3	21	Alt. of ☉'s L. L.,	33	28
	20	4	28	Alt. of ☽'s L. L.,	59	27

To Calculate the Altitudes at time of Mean Distance.

Time of ☽'s first alt.,	19h	57m	43s	Time of ☽'s first alt.,	19h	57m	43s	☽'s first alt.,	60°	53′
Do. second alt.,	20	4	28	Time of mean Dist.,	20	1	5	☽'s second alt.,	59	27
		6	45			3	22		1	26
Time of ☉'s first alt.,	19h	58m	50s	Time of ☉'s first alt.,	19h	58m	50s	☉'s first alt.,	34°	20′
Do. second alt.,	20	3	21	Time of mean Dist.,	20	1	5	☉'s second alt.,	33	28
		4	31			2	15		0	52

6m 45s	:	3m 22s	: :	1° 26′	:	4m 31s	:	2m 15s	: :	0° 52′
3m 22s,		P. L.		1.7281		2m 15s,		P. L.		1.9031
1° 26′,		P. L.		3208		0° 52′,		P. L.		5393
				2.0489						2.4424
6m 45s,		P. L.		1.4260		4m 31s,		P. L.		1.6005
Change of ☽'s alt.,		0° 43′,	P. L.	0.6229	Change of ☉'s alt.,		0° 26′	P. L.		0.8419
☽'s first alt.,		60 53			☉'s first alt.,		34 20			
☽'s alt.,		60 10			☉'s alt.,		33 54			

Hence, the following results are obtained from the observations:—

Time by Watch.	Obs. alt., ☽'s L. L.	Obs. alt., ☉'s L. L.	Obs. Dist.
20h 1m 5s	60° 10′	33° 54′	84° 46′ 55″
Index errors,	— 2	+ 3	— 1 5
	60 8	33 57	84 45 50

Preliminary Work.

Time by Watch,	20h	1m	5s	☽'s S. D., noon,		14′	53″	☽'s Hor. par., noon,		54′ 36″
Long. 149° 40′ W. = by (XI.),	9	58	40	Var. in 12h = — 3″, gives for 6h (XX.),		—	1	Var. in 12h = — 11″, gives for 6h (XX.),		— 5
App. time at Green.,	29	59	45			14	52			54 31
	24			☉'s S. D., noon,		16′	17″			
Do., on January 16,	5	59	45	Daily Var. = 0″, gives for 6h (XIV.),			0			
Eq. of time, noon,	+	10	9			16	17			
Mean time at Green., January 16,	6	9	54							

Calculation of the True Distance.

Observed Dist.,	84°	45′	50″	Obs. alt., ☽'s L. L.,		60°	8′	Obs. alt., ☉'s L. L.,			33°	57′
☉'s S. D.,	+	16	17	☽'s S. D.,	+ 14′ 52″			☉'s S. D.,	+ 16′ 17″			
☽'s S. D.,	+	14	52	Dip,	− 4 30	+	10	Dip,	− 4 30	+	12	
Aug. (III.),	+		14	☽'s App. alt.,		60	18				34	9
Apparent Dist.,	85	17	13	Departure (I.),		+	13	Ref. (IV.),		−	1	
Aux. arc (V.) = 11″, gives (VI.),	+	2	16	☽'s Corr. alt.,		60	31	☉'s Corr. alt.,			34	8
☉'s Corr. (VII.),		+	2									
Corrected Dist.,	85	19	31	Sine,	9.9986						Tan.	1.0882
☉'s Corr. alt.,	34°	8′		Cosec.	2509			☽'s Corr. alt., 60° 31′			Cosec.	0602
☽'s Hor. par.,		54′	31″	P. L.	5187						P. L.	5187
1st arc,		30′	42″ W.	P. L.	7682			2d arc, 3′ 52″ E.			P. L.	1.6671
2d arc,		3	52 E.									
		26	50 W.									
10″ + Corr. (VIII.),			31 W.									
Departure of Dist.,		27	21 W.									
Corrected Dist.,	85°	19	31									
True Distance,	84	52	10									

Remark 2. It may happen that the atmosphere is in a suitable condition for observing a lunar distance, but an undefined horizon may, at same time, prevent the altitudes being observed; in which case it will be necessary to compute the altitudes as in the following example.

For this purpose, the apparent time at the ship must be found nearly correct, which may be done as follows. Take altitudes, as in Section II., either before or after the observation of the lunar distances, from which compute the apparent time at the ship corresponding to the mean of these altitudes.

To this apparent time apply the elapsed time between the observations of the altitudes and distances, and also add the difference of Longitude in time made during the interval, if to the eastward, but subtract it, if to the westward; the result is the apparent time at the ship when the distances were observed; from which the altitudes may be computed by the following rules.

RULES.

1. From the apparent time at the ship, and the Longitude, by account, find the mean time at Greenwich as in Section II., Article I., Preliminary Rule 1, page 7. Corresponding to this time, find the elements from the Nautical Almanac, as in Section II., Article I., in the case of the Sun; or as in Article II., in the case of a fixed Star; or as in Article III., in the case of a Planet; or as in Article IV., in the case of the Moon.

2. *Find the least meridian distance of the body whose altitude is required.* This, in the case of the Sun, is the time from the nearest noon. But if the body be the Moon, a Planet, or a fixed Star: add the Sun's right ascension to the apparent time at the ship, the sum, (deducting 24 hours, if it exceed 24 hours) will be the right ascension of the meridian; the difference between which and the right ascension of the body is the meridian distance of the body; but should this exceed 12 hours, subtract it from 24 hours; the remainder is the least meridian distance of the body.

3. If the Sun's declination and the Latitude are of the same name, first subtract the less from the greater, and then add them; but if they are of contrary names, first add them, and then subtract the less from the greater: the *first* and *second arcs* will thus be obtained.

4. Find the sum of the half-cosines, (XVII.), of the *first* and *second arcs;* but, if the second arc exceeds 90°, take it from 180° to find its supplement, and subtract the half-cosine of this supplement from the half-cosine of the *first arc.* From the Proportional Logarithm of this sum or remainder, increasing the index by 10, subtract the Logarithm, (XVIII.), of the least meridian distance of the body, found by Rule 2: the remainder is the Proportional Logarithm of an arc, which being subtracted from the half-cosine of the *first arc,* will give the half-sine, (XVII.), of the true altitude.

5. To the true altitude add the Refraction, (IV.), which will be the apparent altitude, in the case of the Sun, Star or Planet; but, in the case of the Moon, from this subtract the Moon's parallax in altitude, found by Rule, page 13; the remainder is the Moon's apparent altitude.

EXAMPLE VII.

October, 24, 1849, in Latitude 35° 4′ S., and Longitude, by account, 87° 51′ W., at $3^h\ 10^m\ 5^s$ by a Chronometer, which was losing $12^s.4$ daily, the distance between the nearest limbs of the Sun and Moon was observed to be 96° 22′ 10″, but the altitudes could not be observed on account of the horizon being indistinct.

At $4^h\ 59^m\ 10^s$ by same Chronometer, the horizon being clear, the altitude of the Sun's lower limb was found to be 21° 12′: the height of the eye being 24 feet, the ship being now in Latitude 35° 14′ S., and Longitude, by account, 87° 37′ W., and the apparent time at the ship, $4^h\ 49^m$ nearly. Required the true distance between the centres of the Sun and Moon.

To find the Apparent time.

App. time at ship,	4^h	49^m	0^s	⊙'s Dec., noon, increasing,	11°	49′	32″ S.
Long. 87° 37′ W. = by (XI.),	5	50	28	Corr. for 10^h (XIII.),	+	9	
App. time at Green.,	10	39	28	⊙'s Declination,	11	58	S.
Eq. of time, noon,	—	15	41				
Mean time at Green.,	10	23	47				

Obs. alt., ⊙'s L. L., 21° 12′
Corr. (XVI.), + 9
⊙'s True alt., 21 21

Or, the correction of Declination = the hourly variation, + 51″.95 × $10^h.4$
= + 540″.280 = + 9′ 0″.

Latitude,	35°	14′	S.						
Declination,	11	58	S.						
1st arc,	23	16		Half-cosine,		76′	33″		
2d arc,	47	12		Half-cosine,		56	37		
True alt.,	21	21		Half-sine,		30	20		
				Sum,	2°	13	10	P. L.	10.1309
				Difference,		46	13	P. L.	5905
				Meridian Distance = Apparent time,	4^h	48^m	45^s,	P. L.	9.5404

Time of Alt., by Chron.,	4^h	59^m	10^s			
„ of Dist., by „	3	10	5			
	1	49	5			
Daily loss, 12″.4, gives for 2^h (XIV.),		+	1			
Elapsed time,				1	49	6
				2	59	39
Long. at time of Dist. is 14′ W. of Long. at time of Alt., = (XI.),					—	56
App. time of Distance,				2	58	43

To find the Sun's Altitude when the Distance was observed.

App. time at ship,	2h	58m	43s
Long. 87° 51′ W. = by (XI.),	5	51	24
App. time at Green.,	8	50	7
Eq. of time, noon,	—	15	41
Mean time at Green.,	8	34	26

☉'s Dec., noon, increasing,	11°	49′	32″ S.
Corr. for 9h (XIII.),	+	8	
☉'s Declination,	11	57	S.

Latitude,	35°	4′	S.
Declination,	11	57	S.
1st arc,	23	7	
2d arc,	47	1	

Half-cosine,		76′	39″
Half-cosine,		56	49
Sum,	2°	13	28 ,
App. time,	2h	58m	43s ,
		19′	17″,
Half-sine,		57	22

P. L.	10.1299		
Log.	9.1597		
P. L.	0.9702		

☉'s True alt.,	43°	30′,	
Ref. (IV.),	+	1	
☉'s App. alt.,	43	31	

To find the Moon's Altitude when the Distance was observed.

☽'s R. A., at 8h	=	20h	36m 27s
Do. at 9	=	20	38 31
Hourly var.,		+	2 4
Var. + 2m 4s, Log. (XXI.),			1.4629
Time, 34m 0s, Log.			2467
Corr. + 1m 10s, Log.			1.7096
☽'s R. A., at 8h	=	20h	36m 27s
Corr., as above,		+	1 10
☽'s R. A.,		20	37 37

☽'s Dec., at 8h	=	16°	28′	36″ S.
Do., at 9	=	16	23	23 S.
Hourly var.,		—	5	13
Var. — 5′ 13″, Log. (XXI.),				1.0608
Time, 34m 0s, Log.				2467
Corr. — 2′ 57″, Log.				1.3075
☽'s Dec. at 8h	=	16°	28′	36″ S.
Corr. as above,		—	2	57
☽'s Declination,		16	25	39 S.

☽'s S. D., noon,		14′	53″
Var. in 12h = + 4″, gives for 9h (XX.),	+		3
☽'s S. D.,		14	56
☽'s Par., noon,		54′	37″
Var. in 12h = + 14″, gives for 9h (XX.),	+		11
☽'s Hor. Par.,		54	48
☉'s R. A., noon,	13h	55m	24s
Corr. for 8h 34m (XII.),	+	1	22
☉'s R. A.,	13	56	46
☉'s S. D., noon,		16′	7″

☽'s Meridian Distance.

☉'s R. A.,	13h	56m	46s
App. time,	2	58	43
R. A. of Meridian,	16	55	29
☽'s R. A.,	20	37	37
☽'s Mer. Dist.,	3	42	8

Latitude,	35°	4′	S.
Declination,	16	26	S.
1st arc,	18	38	
2d arc,	51	30	

Half-cosine,		78′	58″
Half-cosine,		51	53
Sum,	2°	10	51,
Mer. Dist.,	3h	42m	8s
		28′	24″
Half-sine,		50′	34″
☽'s Hor. par.,		54′	48″,
Alt.,	37°	22′	
Compt.	52°	38′,	
☽'s Par. in alt.,		43′	33″,

P. L.	10.1385		
Log.	9.3365		
P. L.	0.8020		
P. L.	5165		
Cosec.	0998		
P. L.	6163		

☽'s True alt.,	37°	21′,	
Ref. (IV.),	+	1	
	37	22	
Par. in alt.,	—	44	
☽'s App. alt.,	36	38	

Calculation of the True Distance.

Observed Dist.,	96°	22′	10″	☽'s App. alt.,	36°	38′	⊙'s App. alt.,	43° 31′
⊙'s S. D.,	+	16	7	Dep. (I.),	+	21	Ref. (IV.),	— 1
☽'s S. D.,	+	14	56	☽'s Corr. alt.,	36	59	⊙'s Corr. alt.,	43 30
Aug. (III.),	+		9					
Apparent Dist.,	96	53	22					
Aux. arc (V.) = 1″, gives (VI.),	+	2	30					
Corr. (VII.),	+		2					
Corrected Dist.,	96	55	54	Sine,	9.9968			Tan. 9151
⊙'s Corr. alt.,	43	30		Cosec.	1622		☽'s Corr. alt., 36° 59′,	Cosec. 2207
☽'s Hor. par.,		54′	48″	P. L.	5165			P. L. 5165
1st arc,		38′	0″ W.	P. L.	0.6755		2d arc, 4′ 0″ W.,	P. L. 1.6523
2d arc,		4	0 W.					
		42	0 W.					
10″ + Corr. for Dep. 42′ (VIII.),			28 W.					
Departure of Dist.,		42	28 W.					
Corrected Dist.,	96°	55	54					
True Distance,	96	13	26					

REMARK 3. When extreme accuracy is required, several small corrections must be applied, which are not taken into account in finding the true distance by the preceding Rules.*

1st *Correction for the Spheroidal Figure of the Earth.*

The Moon's horizontal parallax, as given in the Nautical Almanac, is the equatorial horizontal parallax, consequently if the place of observation is not on the equator, the parallax will be less than that found in the Almanac, as it varies directly as the semi-diameter of the earth: the correction to be applied is called the Reduction of the moon's equatorial horizontal parallax, and is found in Table II.

Reckoning the earth a sphere, the apparent horizon of a place is a tangent to the surface of the earth, and is parallel to the true horizon: the perpendicular to this, drawn from the place, meets the heavens in the zenith. But, taking the earth as a spheroid, a line drawn from its centre through the place meets the heavens in the zenith, and a plane perpendicular to this line is the horizon. These zeniths and horizons differ from each other, (according to the Latitude of the place), excepting at the equator and the poles, where they coincide; and, consequently, the altitude of a body taken in reference to the former horizon must differ from the altitude referred to the latter: this difference is the correction of the altitude contained in Table II.

Hence, to find the true distance between the Moon and Sun, or a fixed Star, or a Planet, reckoning the earth a spheroid, the true azimuths of the bodies must be given nearly; and then proceed as follows.

* The demonstrations of the Rules for finding these corrections are given in the Appendix, page 187.

RULES.

1. With the Latitude of the ship enter Table II., and find the Reduction of the Moon's horizontal parallax. Then state as the Moon's horizontal parallax is to the amount of the *first* and *second arcs* found by Rule 7, page 28, so is the reduction of the parallax to the corresponding correction of the Distance, which is always of an opposite name to the amount of the *first* and *second arcs*.

2. With the Latitude of the ship, and the Sun's azimuth, reckoned from the S. or N. according as the Latitude is N. or S., enter Table II., and find the correction of the Sun's altitude. With the *first arc*, found by Rule 7, page 28, expressed in minutes and tenths of a minute, and reckoned as a *Departure*, and with the Sun's corrected altitude as a *Course*, enter a common traverse table, and take out the corresponding *Difference of Latitude*. Multiply this by the correction of the Sun's altitude, found above, increased by its half, the result, cutting off the last two integer figures, will give the corresponding correction of distance in seconds; and it will be of the same name with or of a contrary name to the *first arc*, according as the correction of the Sun's altitude, found from Table II., is additive or subtractive. The calculation is the same for a fixed Star, or a Planet.

3. With the Latitude of the ship, and the Moon's azimuth, enter Table II., and find the correction of the Moon's altitude. With the *second arc*, found by Rule 7, page 28, and the Moon's corrected altitude, proceed as in Rule 2, above given, to find the corresponding correction of the Distance.

4. Take the amount of the three corrections thus found, by the above Rules 1, 2, and 3, and apply the amount to the True Distance found by the Rules at pages 27, 28, and 29: the result is the True distance corrected for the spheroidal figure of the earth.

Note. The names of the three corrections are to be attended to exactly as in Rule 8, page 29, regarding the names of the *first* and *second arcs*.

EXAMPLE.

In Example 3, pages 30, 31, the Latitude of the ship was 14° 50′ N., the corrected altitude of the Sun, 14° 53′, the corrected altitude of the Moon, 77° 57′, and the Moon's horizontal parallax, 57′ 31″. Required the correction of the Distance for the spheroidal figure of the earth; the azimuth of the Sun being S. 69° W., and the azimuth of the Moon, S. 129° W.

The Latitude 14° 50′ gives in Table II., 1″ for the reduction of parallax; and as the amount of the *first* and *second arcs* was found, in Example 3, page 31, to be 4′ 0″ E., the corresponding correction of the Distance will be of a contrary name, or W., and is found as follows:—

	57′ 31″ : 4′ 0″ : : 1″		
	4′ 0″	P. L.	1.6532
	0′ 1″	P. L.	4.0334
			5.6866
	57′ 31″	P. L.	4955
1st *Spheroidal Corr.*,	0″ W.	P. L.	5.1911

To find the Second and Third Corrections.

By Table II., the correction of ⊙'s alt. is	+	2′,	and the correction of)'s alt. is	—	4′
add half,		1	add half,		2
		3			6

The 1st *arc*, by Ex. 3, page 31, is 15′ 39″ W. = 15′.7 W., with which as a *Departure*, and the Sun's alt. 14° 53′, say 15° as a *Course*, the corresponding *Difference of Latitude* is 58.6.

The 2d *arc*, by Ex. 3, page 31, is 19′ 39″ E. = 19′.7 E., with which as a *Departure* and the Moon's alt., 77° 57′, say 78° as a *Course*, the corresponding *Difference of Latitude* is 4.2.

Hence, 58.6 × 3 = 175.8 = (cutting off the two last integer figures) 1″.758 = 2″ W. = 2d *Spheroidal correction*: which is of the same name as the 1st *arc*, as the correction of the Sun's altitude is additive.

And, 4.2 × 6 = 25.2 = (cutting off the two last integer figures) 0″.252 = 0″ W. = 3d *Spheroidal correction*: which is of a contrary name to the 2d *arc*, as the correction of the Moon's altitude is subtractive.

Hence, 1st *Spheroidal Correction*,		0″ W.
2d „ „		2 W.
3d „ „		0 W.
The Whole *Spheroidal* Correction,		2″ W.
True distance, found by Ex. 3, page 31,	70° 47′ 24″	
True distance, corrected for spheroidal figure of Earth,	70 47 22	

Note. The correction for the spheroidal figure of the earth may also be found as follows: Find the true distance by the Rules in pages 27, 28, and 29; excepting that the corrections taken from Table II. must be applied to the altitudes in finding the corrected altitudes by Rule 3, page 28, and the Reduced horizontal parallax of the Moon must be used in the calculation instead of the parallax found from the Nautical Almanac: the result thus obtained will be the true distance corrected for the spheroidal figure of the earth.

EXAMPLE: *same as above.*

)'s App. alt.,		77° 51′	⊙'s App. alt.,		14° 57′	)'s Hor. par.,	57′ 31″	
Dep. (I.),	+ 6′		Ref. (IV.),	— 4′		Reduction (II.),	— 1	
Corr. (II.),	— 4	+ 2	Corr. (II.),	+ 2	— 2	)'s Red. Hor. par.,	57 30	
)'s Corr. alt.,		77 53	⊙'s Corr. alt.,		14 55			

Corrected Dist.,	70° 43′ 54″		Sine,	9.9750			Tan.	4565
⊙'s Corr. alt.,	14 55		Cosec.	5894		)'s Corr. alt., 77° 53′,	Cosec.	0098
)'s Red. Hor. par.,	57′ 30″		P. L.	4956			P. L.	4956
1st arc,	15′ 41″ W.		P. L.	1.0600		2d arc, 19′ 39″ E.,	P. L.	9619
2d arc,	19 39 E.							
	3 58 E.							
10″ + Dep., 4′ (VIII.),	30 W.							
	3 28 E.							
Corrected Dist.,	70° 43 54							
True Distance,	70 47 22							

2d *Correction for the Heights of the Thermometer and Barometer.*

The refractions given in Table IV., correspond to the thermometer at 50°, and the barometer at 29.6 inches; hence, a correction must be applied to them, or any quantities proportional to them, should the height of the thermometer or barometer differ from the above-mentioned mean heights. The corresponding correction of the distance is found as follows.

RULE.

The correction of the distance for refraction is the arc found in Table VI., by Rule 2, page 28, diminished by 20″: with this refraction, and the height of the thermometer, find a correction from Table IV.,* (see explanation of the Table, pages i. and ii.); and with the same refraction, and the height of the barometer, find another correction from same Table. The amount of these two corrections, attending to their algebraical signs, will be the correction of the distance for the heights of the thermometer and barometer.

EXAMPLE.

In Example 3, page 30, suppose the height of the thermometer to have been 89°.2, and the height of the barometer, 28.2 inches. Required the correction of the distance corresponding to these.

The arc found in (VI.), by Ex. 3, page 31, is	3′ 43″,
which diminished by	20
gives the Correction of Dist. for Refraction,	3 23

Correction, by Table IV.,* for Therm. 88°, and Ref. 3′	=	—	16″
„ „ „ „ 88°, and Ref. 23″	=	—	2
„ „ „ „ 88°, and Ref. 3′ 23″	=	—	18
„ „ „ „ 92°, and Ref. 3′	=	—	17″
„ „ „ „ 92°, and Ref. 23″	=	—	2
„ „ „ „ 92°, and Ref. 3′ 23″	=	—	19

	92°		19		89°.2		
	88		18		88		
Hence, if	4°	give	1″	,	1°.2	gives	0″ (by proportion).

Correction for Therm. 88° , and Ref. 3′ 23″	=	—	18
Correction for Therm. 89°.2, and Ref. 3′ 23″	=	—	18″

Correction, by Table IV.,* for Barom. 28.1, and Ref. 3′	=	—	9″
„ „ „ „ 28.1, and Ref. 23″	=	—	1
„ „ „ „ 28.1, and Ref. 3′ 23″	=	—	10
„ „ „ „ 28.3, and Ref. 3′	=	—	8″
„ „ „ „ 28.3, and Ref. 23″	=	—	1
„ „ „ „ 28.3, and Ref. 3′ 23″	=	—	9

	28.3		10″		28.2	
	28.1		9		28.1	
Hence, if	.2	gives	1″	,	.1	gives 0″

Correction for Barom. 28.1, and Ref. 3′ 23″	=	—	10
Correction for Barom. 28.2, and Ref. 3′ 23″	=	—	10

Therefore, Correction for Therm. being	—	18″
and, „ for Barom. being	—	10
The whole Correction of Dist. is	—	28

True Distance, as corrected at page 40,	70°	47′	22
True Distance, as now corrected,	70	46	54

Note. In correcting an altitude, the mean refraction, as found above, should also be corrected; but this may be neglected in finding the True distance, as the altitude will be sufficiently correct for this purpose, without applying such correction.

3d *Correction for the elliptical form of the limb of the Moon or Sun.*

If a horizontal line be drawn through the centre of the Sun or Moon, the refraction of every point on this line is the same as that of the centre; but the refraction of points along the limb diminish, and is the least at the highest point. As the change of refraction is nearly proportional to small changes of the altitude, the limb of the Sun or Moon will thus appear to assume an elliptical form: the same will be the case of the lower limb; but it will appear to be more flattened than the upper limb, as the difference between the refractions of the lowest point of the Moon or Sun and its centre is greater than the difference between the refractions of the centre and highest point. These corrections of the distance, for the Moon and Sun, are found as follows: the same method is applicable for the Moon and a Fixed star, or a Planet, excepting that the correction only for the Moon requires to be calculated, as there is no correction for a Fixed star, or Planet.

RULES.

1. Find the parallax of the Moon in altitude, as in Rule, page 13: or, with the apparent altitude of the Moon as a *course*, and the horizontal parallax as a *distance*, find from a common traverse table, the *difference of latitude*, which will be the parallax in altitude.

2. To the departure of distance, found by Rule 8, page 29, apply the quantity 20″ E., increased by 10″ in the case of the Sun, or by the horizontal parallax of the Planet in the case of a planet. With this corrected departure as a *difference of latitude*, and the parallax of the Moon as a *distance*, find from a common traverse table, the *course*, which will be the angle at the Moon.

3. To the Logarithmic sine of the angle at the Moon, (IX.), add the Logarithmic sine of the Moon's zenith distance; and from the sum of these Logarithms, subtract the Logarithmic sine of the Sun's zenith distance, the remainder is the Logarithmic sine of the angle at the Sun.

4. Enter the following Table with the angle at the Moon, at the top of the table, and the Moon's altitude in a side column, and take out the correction: which is *additive* to the Distance, or *subtractive* from it, according as the *farthest* or *nearest* limb of the Moon was observed in taking the distance.

The Correction for the Sun is found in the same manner. And the amount of these corrections is the correction of Distance for the elliptical forms of the Sun and Moon.

TABLE.

CORRECTION OF THE LUNAR DISTANCE,
For the elliptical form of the Sun, or Moon.

Alt.	Angle at the Sun, or Moon.															
	0°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	90°
°	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
7	15	15	14	13	12	11	10	9	8	6	5	4	3	2	1	0	0
8	12	12	11	11	10	9	8	7	6	5	4	3	2	1	1	0	0
9	10	10	9	9	8	8	7	6	5	4	3	3	2	1	1	0	0
10	8	8	8	7	7	6	5	5	4	3	3	2	1	1	0	0	0
11	6	6	6	5	5	5	4	4	3	2	2	2	1	1	0	0	0
12	5	5	5	4	4	4	3	3	3	2	2	1	1	1	0	0	0
13	4	4	4	4	3	3	3	2	2	1	1	1	1	0	0	0	0
14	3	3	3	3	3	2	2	2	2	1	1	1	1	0	0	0	0
15	3	3	3	3	3	2	2	2	2	1	1	1	1	0	0	0	0
20	2	2	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0
30	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

For the *farthest* limb, *add*: for the *nearest* limb, *subtract*.

EXAMPLE.

In Example 3, page 30, required the correction of the Distance arising from the elliptical forms of the Sun and Moon.

With the apparent altitude of the Moon, 77° 51′, say 78°, as a *Course*, and the Moon's horizontal parallax, 57′ 31″, say 57′.5 as a *Distance*, the corresponding *Difference of Latitude* is 12′.0 = the parallax of the Moon in altitude.

The Departure of the Distance was found to be 3′ 30″ E., page 31, which increased by 30″ E., gives 4′ 0″, say 4.0: with 4.0 as a *Difference of Latitude*, and the parallax of the Moon in altitude, 12.0 as a *Distance*, the corresponding *Course* is 70° = the angle at the Moon.

Angle at the Moon,	70°,	Log. Sine	9.9730
Moon's altitude,	77° 51′		
Moon's zen. dist.,	12 9,	Log. Sine	9.3232
			19.2962
Sun's altitude,	14 57		
Sun's zen. dist.,	75 3,	Log. Sine	9.9850
Angle at the Sun,	12°,	Log. Sine,	9.3112

Note. The zenith distance is found by subtracting the altitude from 90°.

With the angle at the Moon 70°, and altitude 77° 51′, the correction in the above Table is			— 0″
With the angle at the Sun 12°, and altitude 14 57 the correction in the above Table is			— 3
Correction for elliptical forms of Sun and Moon,			— 3
True Distance, as corrected at page 42,	70	46	54
True Distance, as now corrected,	70	46	51

Note. Instead of applying the several corrections separately, we may at once apply their amount to the True Distance as calculated by Rules, pages 27, 28, and 29: thus,

True Distance, as calculated at page 31,			70° 47′ 24″
Correction for Spheroidal figure of earth, page 40, 2″ W. = — 2″			
„ for Therm. and Barom., page 42, = — 28			
„ for Elliptical forms of Sun and Moon, page 44, = — 3			
			— 33
True Distance, including the small corrections,	70	46	51

EXERCISES.

1. In Example 4, page 31, suppose the azimuth of the Moon to be S. 167° W., the azimuth of the Star S. 69° E., the Temperature 78°, and the height of the Barometer 29.0 inches. Required the True distance, allowing for the small corrections.

Answer. The Spheroidal correction is 2″ W. or — 2″; the correction for the Therm. and Barom. is — 24″; and the correction for the elliptical form of the Moon is 0″. Hence, the True distance corrected is 101° 50′ 27″.

2. In Example 5, page 32, suppose the azimuth of the Moon to be S. 167° W., the azimuth of the Planet S. 77° W., the Temperature 80°, and the height of the Barometer 28.6 inches. Required the True distance, allowing for the small corrections.

Answer. The Spheroidal correction is 1″ W. or — 1″; the correction for the Therm. and Barom. is — 15″; and the correction for the elliptical form of the Moon is 0″. Hence, the True distance corrected is 59° 31′ 4″.

3. In Example 6, page 33, suppose the azimuth of the Moon to be N. 109° W., the azimuth of the Sun S. 78° W., the Temperature 89°, and the height of the Barometer 30.7 inches. Required the True distance, allowing for the small corrections.

Answer. The Spheroidal correction is 2″ E. or + 2″; the correction for the Therm. and Barom. is — 6″; and the correction for the elliptical forms of the Sun and Moon is 0″. Hence, the True distance corrected is 84° 52′ 6″.

4. In Example 7, page 36, suppose the azimuth of the Moon to be N. 96° E., and the azimuth of the Sun N. 109° W., the Temperature 62°, and the height of the Barometer 28.5 inches. Required the True distance, allowing for the small corrections.

Answer. The Spheroidal correction is 6″ E. or + 6″; the correction for the Therm. and Barom. is — 8″; and the correction for the elliptical forms of the Sun and Moon is 0″. Hence, the True distance corrected is 96° 13′ 24″.

ARTICLE II.

To find the Mean Time at Greenwich by a Lunar Distance; and, thence the error of the Chronometer, and Longitude of the Ship.

RULES.

1. Find the True Distance as in Article 1.

2. Find from pages XIII. to XVIII. in the Nautical Almanac, the Distances between which the True distance falls. Take out the first of these, and place it below the True distance; also write after it, the Proportional logarithm taken from the Almanac, and note the time of this distance as given in the Almanac.

3. Find the difference between the True distance and the distance written below it, and from the Proportional logarithm (X.), of this difference subtract the Proportional logarithm taken from the Almanac; the remainder is the Proportional logarithm of a portion of time to be added to the time noted, as above, from the Almanac: the result is the Greenwich Mean time of the True distance.

4. Having obtained the Greenwich Mean Time, the difference between it, and the time shown by the Chronometer when the Distance was observed will be the error of the Chronometer, from which the Longitude of the ship may be found by means of an altitude, as in Section III. This Longitude will be that of the ship when the altitude is taken.

REMARK 1. If either of the altitudes observed along with the Distance is suitable for finding the time; the Longitude may, at once, be found by computing the Mean Time at the ship from this altitude, the difference between which and the Greenwich Mean Time, found by the above Rules, will be the Longitude. This will evidently be applicable in case of a Chronometer not being on board the ship. But, as it is necessary that the altitude, from which the time is computed, should be observed when the body is near the prime vertical, it may often happen that the delaying until this shall be the case may occasion the loss of the lunar observation, as the state of the atmosphere may change so as to prevent such an observation being taken. Should, however, a common seconds watch be at hand, this may be used as a substitute for a Chronometer, and thus the lunar distance may be taken without reference to the altitudes being suitable for finding the Mean Time at the ship. In this case, the altitude for finding the time at the ship should be taken as near as possible to the observation of the lunar distance, as the irregularity of the going of the watch will thereby have the less effect in producing an error in the Longitude.

EXAMPLE I.

Required the Longitude of the ship from the observations given in Example 3, page 30: the mean time at the ship to be found from the Sun's altitude which was taken at the same time as the Lunar distance.

Calculation of the Greenwich Mean Time.

True Distance, (by Ex. 3, page 31),	70° 47′ 24″		
Distance, by Naut. Alm., at VI^h,	69 35 19 ,	P. L.	2885
Difference,	1 12 5 ,	P. L.	3974
Time past VI^h,	2^h 20^m 4^s ,	P. L.	1089
Add	6 0 0		
Greenwich Mean Time,	8 20 4		

Calculation of the Mean Time at the Ship.

App. time at ship, nearly,	5^h 20^m 0^s	Equat. time, noon,	+ 2^m 14^s	⊙'s Dec., noon,	23° 24′ 13″ N.
Long. by account, 45° 40′ W. = , (XI.),	3 2 40	Daily Var., 13^s increasing gives for 8^h (XIV.),	+ 4	Hourly var. — 4″.55 × 8^h 25^m, or 8^h.4	
App. time at Green., nearly,	8 22 40	Equat. of time,	+ 2 18	= — 38″.220 ,	— 38
Equat. of time, noon,	+ 2 14	Alt. ⊙'s L. L.	14° 46′	⊙'s Declination,	23 23 35 N.
Green. Mean time, nearly,	8 24 54	Corr. (XVI.),	+ 8		
		⊙'s True alt.,	14 54		

Latitude,	14° 50′ N.				
Declination,	23 24 N.				
1st arc,	8 34 ,	Half-cosine,	82′ 24″		
2d arc,	38 14 ,	Half-cosine,	65 27		
True altitude,	14 54 ,	Half-sine,	21 26		
		Sum,	2° 27 51 ,	P. L.	10.0855
		Difference,	1 0 58 ,	P. L.	.4702
Meridian distance = App. time,			5^h 19^m 37^s ,	Log.	9.6153
Equation of time,			+ 2 18		
Mean Time at ship,			5 21 55		

Calculation of the Longitude.

Greenwich Mean Time, as above,	8^h 20^m 4^s	
Mean Time at ship, " ,	5 21 55	
	2 58 9	
	60	
	4) 178° 9′	
Longitude of the ship,	44° 32′ 15″ W.	

EXAMPLE II.

In Example 4, pages 31 and 32, a chronometer on board the ship showed 3^h 49^m 32^s when the Lunar distance was observed. And, on August 3, in Latitude 20° 15′ N., when the same chronometer showed 7^h 39^m 37^s, the altitude of the star α Arietis was observed to be 66° 7′, eastward of the meridian. Required the Longitude of the ship, when the star's altitude was taken

on August 3, calculating both by the Lunar distance and the chronometer; the original error of the chronometer having been ascertained to be $40^m\ 3^s$ fast of Greenwich mean time on June 5, 1849, at noon, and gaining $2^s.4$ daily.

To find the Error of the Chronometer from the Lunar Distance.

True Distance, (by Ex. 4, page 32),	101^0	$50'$	$53''$		
Distance, by Naut. Alm., at III^h,	101	54	28	P. L.	3116
Difference,		3	35	P. L.	1.7010
Time past III^h,		7^m	21^s	P. L.	1.3894
Add,	3^h	0	0		
Greenwich Mean Time,	3	7	21		
Time by Chronometer,	3	49	32		
Error of Chronometer,	0	42	11	fast.	

Calculation of the Mean Time at Ship on Aug. 3.

Time by Chron.,	7^h	39^m	37^s	⊙'s R. A., noon,	8^h	53^m	40^s	✱'s R. A.,	1^h	58^m	40^s
Error, fast,	—	42	11	Corr. for 7^h (XII.),	+	1	7	✱'s Dec.,	22^0	$44'$	$45''$ N.
	6	57	26	⊙'s R. A.,	8	54	47	✱'s Obs. alt.,	66^0	$7'$	
Gain in interval = 1 day 4^h at $2^s.4$ daily,	—		2.8	Equat. of time, noon,	+	5^m	52^s	Corr., (XV.),	—	5	
				Daily var. — 5^s, gives for 7^h (XIV.),	—	1		✱'s True alt.,	66	2	
Green. Mean Time,	6	57	23.2	Equat. of time,	+	5^m	51^s				

Latitude,	20^0	$15'$	N.					
Declination,	22	45	N.					
1st arc,	2	30	,	Half-cosine,	$83'$	$15''$		
2d arc,	43	0	,	Half-cosine,	60	57		
True alt.,	66	2	,	Half-sine,	76	9		
				Sum,	2^0	$24'$	$12''$	P. L. 10.0963
				Difference,		7	6	P. L. 1.4040
				✱'s Meridian distance,	1^h	42^m	34^s E.,	Log. 8.6923
				✱'s R. A.,	1	58	40	
				R. A. of Meridian,	0	16	6	
				⊙'s R. A.,	8	54	47	
				App. time at ship,	15	21	19	
				Equat. of time,	+	5	51	
				Mean Time at ship,	15	27	10	

Calculation of the Longitude.

Mean Time at ship, as above,	15^h	27^m	10^s
Greenwich Mean Time, " "	6	57	23
	8	29	47
	60		
	$4\overline{)509^0}$	$47'$	
Longitude, by Lunar Distance,	127^0	$26'$	$45''$ E.

Or:

Time of Alt., by Chronometer,	7h 39m 37s
Original error of Chronometer, fast,	— 40 3
	6 59 34
Accumulated gain for 59 days 7h, at 2s.4 daily,	— 2 22
Greenwich Mean Time, by Chronometer,	6 57 12
Mean Time at ship, as above,	15 27 10
	8 29 58
	60
	4) 509° 58′
Longitude, by Chronometer,	127° 29′ 30″ E.

Note. It is evident from the above Example, that the method of finding the Longitude by Lunar Distances differs from that by chronometers, only in respect of the error of the chronometer, which in the former case is computed from the Lunar Distance, instead of finding it from the original error, and the accumulated rate. The method of Lunar Distances, therefore, affords an excellent check on a chronometer, as it will show whether the regularity of the rate of the chronometer may be depended on within a sufficient degree of accuracy. A Lunar Distance, therefore, serves the same purpose as a Greenwich clock, and an Altitude answers for a ship clock; as the former gives Greenwich mean time, and the latter, ship mean time.

EXAMPLE III.

In Example 5, pages 32 and 33, a chronometer on board the ship showed 4h 20m 47s when the Lunar distance was observed. And, in the morning of the same day, June 28, in Latitude 10° 5′ N., when the same chronometer showed 16h 8m 12s on June 27, the altitude of the Sun's lower limb was observed to be 26° 15′. Required the Longitude of the ship, when the Sun's altitude was taken, calculating both by the Lunar distance and the chronometer: the original error of the chronometer having been ascertained to be 52m 13s fast of Greenwich mean time on May 20, 1849, at noon, and losing 6s.8 daily.

To find the error of the Chronometer from the Lunar Distance.

True Distance, (by Ex. 5, page 33),	59° 31′ 20″		
Distance, by Naut. Alm., at IIIh,	59 14 24	P. L.	2968
Difference,	16 56	P. L.	1.0265
Time after IIIh,	0h 33m 32s ,	P. L.	7297
Add,	3 0 0		
Greenwich Mean Time,	3 33 32		
Time by Chronometer,	4 20 47		
Error of Chronometer,	0 47 15 fast.		

Calculation of the Mean Time at ship.

Time by Chron.,	16h 8m 12s	⊙'s Dec., noon, June 27,	23 20′ 10″ N.	Eq. time, noon,	+ 2m 39s	
Error, fast,	— 47 15			Daily var. + 12s, gives for 15h (XIV.),	+ 8	
Rate in interval = 12h at 6s.8 daily,	15 20 57 / 3	Daily var. = −6″.60, × 15h = 99″.00	— 1 39	Eq. of time,	+ 2 47	
Green. Mean Time,	15 20 54	⊙'s Declination,	23 18 31 N.	Alt. ⊙'s L. L.,	26° 15′	
				Corr. (XVI.),	+ 10	
				⊙'s True alt.,	26 25	

Latitude,	10	5′	N.							
Declination,	23	19	N.							
1st arc,	13	14	,	Half-cosine,	81′	7″				
2d arc,	33	24	,	Half-cosine,	69	34				
True alt.,	26	25	,	Half-sine,	37	4				
				Sum,	2°	30	41	,	P. L.	10.0772
				Difference,		44	3	,	P. L.	6113
				Meridian Distance,	4h	21m	50s	,	Log.	9.4659
					24	0	0			
				Apparent time,	19	38	10			
				Eq. of time,	+	2	47			
				Mean time at ship,	19	40	57			

Calculation of the Longitude.

Mean Time at ship, as above,	19h	40m	57s
Greenwich Mean Time, „ „	15	20	54
	4	20	3
	60		
4) 260°	3′		
Longitude, by Lunar Distance,	65°	0′	45″ E.

Or:

Time of Alt., by Chronometer,	16h	8m	12s
Original error of Chronometer,	—	52	13
	15	15	59
Accumulated rate for 38 days 15h at 6s.8 daily,		4	22
Mean Time at Greenwich,	15	20	21
Mean Time at ship, as above,	19	40	57
	4	20	36
	60		
4) 260°	36′		
Longitude, by Chronometer,	65°	9′ E.	

REMARK 2. As a Lunar distance gives the error of the chronometer at the time of the observation, the error may be ascertained for noon of the given day by applying to the calculated error the gain or loss of the chronometer during the interval. And thus if several observations of Lunar distances be taken, either during the day, between the Sun and Moon; or at night, between the Moon and fixed Stars or Planets; and the error of the chronometer, at noon, found from each observation: the mean of these errors will give an error more to be depended on than that deduced from a single observation. Lunar distances, although not all taken on the same day, may thus be combined together for finding the error of the chronometer, by deducing the error for noon of any one day from each observation. In taking several observations, for the purpose of combining their results, it is proper to take distances of stars to the eastward of the Moon, and the distances of an equal number of stars to the westward; as the errors of observation will thus be more likely to counteract each other than if the stars, used in the observations, were all on the same side of the Moon. In taking a single observation of a Lunar distance, that star should be selected, whose distance from the Moon changes most rapidly, as the errors of observation will thereby the less effect the result of the calculation: the smaller the proportional logarithm in the Nautical Almanac is, the quicker is the change of distance from the Moon.

REMARK 3. The Greenwich mean time corresponding to the True Lunar distance was found, by Rules, page 45, on the supposition that the rate of change in the distance is proportional to the change of the corresponding time. But as the Moon's motion is not uniform, it frequently happens that this will cause an error of some importance in the time thus calculated. And consequently a correction must be applied, which is called the correction for the inequality of the Moon's motion.

To find the Correction for the Inequality of the Moon's motion.

RULES.

1. Find the approximate Greenwich Mean Time by Rules, page 45.

2. Take the difference between the Proportional Logarithms given in the Nautical Almanac opposite to the distances between which the true distance falls.

3. With this difference of logarithms, and the approximate interval or portion of time found by Rules, page 45, take out the corresponding number of seconds from the following Table. This is the correction required, and is to be *added to* the approximate Greenwich Mean Time, if the two Proportional Logarithms are *decreasing;* but it is to be *subtracted from it,* if these Logarithms are *increasing.*

TABLE.

CORRECTION OF THE GREENWICH MEAN TIME,

For the Inequality of the Moon's motion.

Diff. of Prop. Log. in the Naut. Alm.	Interval. 0h						1h				Diff. of Prop. Log. in the Naut. Alm.	Interval. 0h						1h			
	0m	10m	20m	30m	40m	50m	0m	10m	20m	30m		0m	10m	20m	30m	40m	50m	0m	10m	20m	30m
6	0s	0s	1s	1s	1s	1s	2s	2s	2s	2s	114	0s	8s	14s	20s	24s	28s	31s	34s	35s	35s
12	0	1	1	2	3	3	3	4	4	4	120	0	8	15	21	26	30	32	36	37	37
18	0	1	2	3	4	4	5	5	6	6	126	0	9	16	22	27	31	34	37	39	39
24	0	2	3	4	5	6	6	7	7	7	132	0	9	17	23	28	33	36	39	40	41
30	0	2	3	5	6	7	8	9	9	9	138	0	9	18	24	30	34	37	41	42	43
36	0	2	4	6	8	9	10	11	11	11	144	0	10	18	25	31	36	39	43	44	45
42	0	3	5	7	9	10	11	12	13	14	150	0	10	19	26	32	37	40	44	47	47
48	0	3	6	8	10	12	13	14	15	15	156	0	11	20	27	33	39	42	46	48	48
54	0	4	7	9	12	13	15	16	17	17	162	0	11	21	28	35	40	44	48	50	50
60	0	4	7	10	13	15	16	18	18	19	168	0	11	21	29	36	42	45	50	52	52
66	0	4	8	11	14	16	18	19	20	20	174	0	12	22	30	37	43	47	51	53	54
72	0	5	9	12	15	18	19	21	22	22	180	0	12	23	31	39	45	49	53	55	56
78	0	5	10	13	17	19	21	23	24	24	186	0	12	24	32	40	46	50	55	57	58
84	0	6	10	14	18	21	23	25	26	26	192	0	13	24	33	41	48	52	57	59	60
90	0	6	11	15	19	22	24	27	28	28	198	0	13	25	34	43	49	53	58	61	62
96	0	7	12	17	21	25	26	28	29	30	204	0	14	26	35	44	51	55	60	63	63
102	0	7	12	18	22	25	27	30	31	32	210	0	14	26	36	45	52	57	62	64	65
108	0	7	13	19	23	27	29	32	33	33	216	0	14	27	37	46	54	58	64	66	67
	0m	50m	40m	30m	20m	10m	0m	50m	40m	30m		0m	50m	40m	30m	20m	10m	0m	50m	40m	30m
	3h	0h					1h					3h	2h					1h			
	Interval.											Interval.									

Note. A similar Table to the above is given in the Nautical Almanac; it is at page 584 of the Almanac for 1849.

EXAMPLE.

Required the Greenwich mean time, at which the true distance between the Moon and Fomalhaut is 34° 15′ 10″, on June 14, 1849.

True Distance,	34	15′	10″		
Distance, by Naut. Alm., at noon,	33	36	28	P. L.	3718
Difference,		38	42	P. L.	6676
Approximate Interval or time past noon,	1h	31m	5s	P. L.	2958
Add,	0	0	0		
Approximate Greenwich Mean Time,	1	31	5		

By the Nautical Almanac, the distances between which the true distance falls are at noon and III hours, and the corresponding proportional logarithms are 3718 and 3605, the difference between which is 113 *decreasing*. And, by Table, page 50, this difference 113, and the approximate interval, above found, 1h 31m 5s, or the nearest thereto as given in the Table, 114, and 1h 30m, give correction 35s; which is *additive*, as the logarithms taken from the Almanac were decreasing.

Approximate Greenwich Mean Time,	1h	31m	5s
Correction, as above,	+		35
Greenwich Mean Time,	1	31	40

Note. The correction for the inequality of the Moon's motion, in the above Example, amounts to 35s, or 8¾ miles of longitude.

REMARK 3. An error in the distance produces, at an average, an error of 30 times its amount in the longitude; and, therefore, if the error of distance be expressed in seconds, half this will be the error in longitude expressed in miles: thus, if the error in the distance be 20″, the corresponding error in longitude is 30 times 20″ or 600″ = 10′, or half of 20 = 10 miles. Hence, the small corrections for the spheroidal figure of the earth, and the apparent elliptical form of the Sun or Moon, pages 38 and 42, may in general be neglected, as their omission will not produce an important error in the longitude. But the correction for the heights of the thermometer and barometer, page 41, and the correction for the inequality of the Moon's motion, page 50, may become too considerable to be omitted. The former of these corrections depends on the correction of the distance for refraction; and this will be small, when the altitudes of the bodies are nearly equal: it may also be remarked that the correction for the elliptical form of the Sun or Moon will be very small under the same circumstances.

EXERCISES

IN FINDING THE TRUE FROM AN APPARENT LUNAR DISTANCE.

The following Exercises may be solved immediately after Example VII., page 36, or after Example II., page 30. The mark ⊙ signifies that the distance between the Sun and Moon is observed; and the mark ✱, that the distance is between the Moon and a fixed Star.

Ex.	☽'s Hor. Par.	App. Alt. of ☉ or ✳.	App. Alt. of ☽.	Apparent Dist.	True Distance.
1	56′ 20″	☉ 20° 45′	24° 0′	59° 58′ 55″	59° 50′ 22″
2	58 46	✳ 27 45	48 20	81 23 40	81 4 32
3	56 30	☉ 25 15	19 20	72 21 42	72 3 53
4	61 12	✳ 11 50	44 35	64 36 42	64 46 18
5	59 20	☉ 72 20	31 10	75 28 45	74 40 4
6	59 20	☉ 54 10	48 42	76 0 35	75 23 30
7	56 55	☉ 31 35	14 55	101 33 30	101 2 51
8	55 20	✳ 48 20	22 45	77 44 5	77 8 28
9	60 40	✳ 42 55	26 5	55 2 50	54 32 30
10	54 22	✳ 49 30	34 30	92 10 40	91 30 8
11	56 15	☉ 66 49	21 32	57 16 20	56 30 12
12	58 33	☉ 19 5	41 5	103 29 30	103 3 21
13	56 13	✳ 24 50	12 28	51 28 33	51 9 47
14	57 22	✳ 17 55	35 5	35 48 10	36 5 25
15	55 0	☉ 33 25	51 0	64 4 50	63 53 12
16	55 55	✳ 19 49	61 55	42 21 15	42 49 22

EXERCISES

IN FINDING THE LONGITUDE BY LUNAR DISTANCES.

1. April 19, 1849, in latitude 30° 5′ N., and longitude by account, 171° 20′ W., about $19^h\ 50^m$ apparent time by watch, (being April 20, at $7^h\ 50^m$ A. M.), the distance between the nearest limbs of the Sun and Moon was observed to be 29° 50′ 0″; at the same time, the altitude of the Moon's upper limb was 9° 54′, and the altitude of the Sun's lower limb was 30° 11′, eastward of the meridian: the height of the observer's eye being 20 feet, and the instruments adjusted. Required the true distance and the longitude of the ship, calculating the mean time at the ship from the Sun's altitude.

Answer. The true distance, 29° 43′ 13″; mean time at Greenwich, April 20, at $7^h\ 17^m\ 47^s$, or April 19, at $31^h\ 17^m\ 47^s$; mean time at ship, April 19, at $19^h\ 52^m\ 36^s$; and the longitude of the ship, 171° 17′ 45″ W.

Note. By the Nautical Almanac, the Sun's declination is 11° 34′ 27″.5 N. at noon, on April 20, and 11° 54′ 53″.6 N. at noon, on April 21; the equation of time is $1^m\ 10^s$ at noon, on April 20, and $1^m\ 23^s$ at noon, on April 21, subtractive from apparent time; the Sun's semidiameter is 15′ 56″. The Moon's semidiameter, on April 20, is 16′ 1″ at noon, and 16′ 8″ at midnight; and the Moon's horizontal parallax is 58′ 47″ at noon, and 59′ 12″ at midnight. And the true distance between the Sun and Moon is 30° 25′ 25″ on April 20, at VI hours Greenwich mean time, and 28° 47′ 46″ at IX hours; also the intermediate proportional logarithm is 2656.

2. July 21, 1849, (astronomical time), in latitude 40° 5′ N. when a chronometer, which was $20^m\ 30^s$ slow of Greenwich mean time, showed $22^h\ 13^m\ 30^s$, the altitude of the Sun's lower limb was observed in the morning, in order to ascertain the time at the ship, and was found to be 33° 9′. And, in order to ascertain the longitude, the distance between the nearest limbs of the Sun and Moon was observed to be 36° 41′ 11″, when the same chronometer showed, July 22, at $1^h\ 49^m\ 30^s$; the altitude of the Sun's lower limb being then 68° 31′, and the altitude of the Moon's upper limb 39° 10′. Required the true distances, and the error of the chronometer as deduced from it; also the longitude of the ship, both by the lunar observation, and the chronometer, when the Sun's altitude was taken in the morning for finding the time: the height of the observer's eye being 18 feet, and the instruments adjusted.

Answer. The true distance, 36° 32′ 5″, thence the mean time at Greenwich, July 22, at $2^h\ 10^m\ 25^s$, and hence the error of the chronometer $20^m\ 55^s$ slow of Greenwich mean time. The mean time at ship from Sun's altitude, July 21, at $19^h\ 54^m\ 20^s$; and the mean time at Greenwich is $22^h\ 34^m\ 0^s$, by taking the original error of the chronometer, or $22^h\ 34^m\ 25^s$, by taking the error as deduced from the lunar; hence the longitude is 39° 55′ W. by chronometer, and 40° 1′ 15″ W. by lunar.

Note. By the Nautical Almanac, the Sun's declination is 20° 28′ 13″ 4 N., at noon, on July 21, and 20° 16′ 25″.5 N., at noon, on July 22; the equation of time is $6^m\ 3^s.19$, at noon, on July 21, and $6^m\ 5^s.99$, at noon, on July 22, additive to apparent time; the Sun's semidiameter is 15′ 46″. The Moon's semidiameter, on July 22, is 16′ 2″.4, at noon, and 15′ 55″.1, at midnight; and the corresponding horizontal parallaxes are 58′ 51″.9 and 58′ 25″.1. The true distance between the Sun and Moon, on July 22, is 35° 21′ 30″ at noon, and 36° 58′ 54″ at III hours, and the intermediate proportional logarithm is 2667.

3. On December 20, 1848, at noon, the error of a chronometer was found to be $15^m\ 15^s$ fast of Greenwich mean time, and losing $5^s.4$ daily. On February 13, 1849, (astronomical time), in latitude 35° 9′ S., when the same chronometer showed $21^h\ 47^m\ 40^s$, the altitude of the Sun's lower limb was observed in the morning, in order to ascertain the time at the ship, and was found to be 24° 47′. And, in order to ascertain the longitude, the distance between the star Regulus and the remote limb of the Moon was observed to be 90° 14′ 50″, when the same chronometer showed, February 14, at $18^h\ 40^m\ 13^s$; the altitude of the Moon's upper limb being then 63° 30′, and the altitude of Regulus 13° 14′. Required the true distance, and the error of the chronometer as deduced from it; also the longitude of the ship, both by the lunar observation and the chronometer, when the Sun's altitude was taken in the morning for finding the time; the height of the observer's eye being 18 feet, and the instruments adjusted.

Answer. The true distance, 89° 51′ 24″, thence the mean time at Greenwich, Feb. 14, at $18^h\ 29^m\ 54^s$, and hence the error of the chronometer $10^m\ 19^s$ fast of Greenwich mean time, when the lunar distance was taken, and therefore $10^m\ 24^s$ fast when the Sun's altitude was taken for finding the time. The mean time at the ship from the Sun's altitude, February 13, at $19^h\ 40^m\ 38^s$; and the mean time at Greenwich is $21^h\ 37^m\ 27^s$ by applying the original error, and the rate to the time by chronometer, or $21^h\ 37^m\ 16^s$ by using the error as found from the lunar observation; hence the longitude is 29° 12′ 15″ W. by chronometer, and 29° 9′ 30″ W. by lunar.

Note.—By the Nautical Almanac, the Sun's declination is 13° 17′ 11″.8 S., at noon, on February 13, and 12° 56′ 51″.4 S., at noon, on February 14; the equation of time is $14^m\ 29^s.86$, at noon, on February 13, and $14^m\ 27^s.63$, at noon, on February 14, additive to apparent time; the Sun's semidiameter is 16′ 13″. The Moon's semidiameter, on Feb. 14, at midnight, is 14′ 47″.2, and on Feb. 15, at noon, it is 14′ 46″.4; and the corresponding parallaxes are 54′ 15″.8 and 54′ 12″.9. The true distance between Regulus and the Moon, on February 14, is 89° 36′ 40″ at XVIII. hours, and 91° 5′ 20″ at XXI. hours, and the intermediate proportional logarithm is 3075.

4. On May 1, 1849, at noon, the error of a chronometer was found to be $20^m\ 13^s$ fast of Greenwich mean time, and gaining $4^s.6$ daily. On July 8, (astronomical time), in latitude $40^\circ\ 10'$ S, when the same chronometer showed $17^h\ 5^m\ 29^s$, the altitude of the planet Saturn was observed, in order to find the time at the ship, and was found to be $28^\circ\ 49'$, eastward of the meridian. And, in order to ascertain the longitude, the distance between the centre of the planet Mars, and the nearest limb of the Moon, was observed to be $69^\circ\ 27'\ 32''$, when the same chronometer showed, July 8, at $18^h\ 25^m\ 30^s$; the altitude of the Moon's lower limb being then $60^\circ\ 26'$, and the altitude of Mars $12^\circ\ 37'$. Required the true distance between the Moon and Mars, and the error of the chronometer as deduced from it; also the longitude of the ship, both by the lunar observation, and the chronometer, when Saturn's altitude was taken: the height of the observer's eye being 18 feet, and the instruments adjusted.

Answer. The true distance $69^\circ\ 51'\ 25''$, thence the mean time at Greenwich, July 8, at $17^h\ 59^m\ 46^s$, and hence the error of the chronometer $25^m\ 44^s$ fast of Greenwich mean time. The mean time at the ship from Saturn's altitude, July 8, at $14^h\ 4^m\ 36^s$; and the mean time at Greenwich is $16^h\ 40^m\ 0^s$, by applying the original error and rate to the time by chronometer, or $16^h\ 39^m\ 45^s$, by using the error as found from the lunar observation; hence the longitude is $38^\circ\ 51'\ 0''$ W. by chronometer, and $38^\circ\ 47'\ 15''$ W. by lunar.

Note. By the Nautical Almanac, the right ascension of Saturn is $0^h\ 32^m\ 41^s.78$, at noon, on July 8, and $0^h\ 32^m\ 46^s.32$, at noon, on July 9, also the hourly variation is $+\ 0^s.18$; the declinations of Saturn for same time are $0^\circ\ 56'\ 16''.0$ N., and $0^\circ\ 56'\ 26''.9$ N., and hourly variation $+\ 0''.4$. The right ascension of the Sun is $7^h\ 9^m\ 57^s.56$, at noon, on July 8, and $7^h\ 14^m\ 3^s.17$, at noon, on July 9, and the hourly variation $+\ 10^s.235$; the equation of time is $4^m\ 40^s.35$, at noon, on July 8, and $4^m\ 49^s.40$, at noon, on July 9, additive to apparent time. The Moon's semidiameter is $15'\ 5''.8$, on July 8, at midnight, and $15'\ 9''.9$, on July 9, at noon; and the corresponding parallaxes are $55'\ 24''.0$ and $55'\ 38''.9$. The true distance between Mars and the Moon, on July 8, is $71^\circ\ 19'\ 30''$, at XV. hours, and $69^\circ\ 51'\ 18''$, at XVIII. hours, and the intermediate proportional logarithm is 3098. The horizontal parallax of Mars is $6''$.

5. In latitude $20^\circ\ 13'$ N., the altitude of the Sun's lower limb was observed in the morning, in order to ascertain the time at the ship, and found to be $32^\circ\ 10'$, when a chronometer, which was $26^m\ 20^s$ fast of Greenwich mean time, showed, April 17, at $6^h\ 24^m\ 19^s$. And, in order to find the longitude, the following altitudes, and distances between the nearest limbs of the Sun and Moon were taken by one observer; the times being noted from same chronometer. Required the true distance, and the error of the chronometer as deduced from it; also the longitude of the ship, both by the lunar observation, and the chronometer, when the Sun's altitude was taken in the morning for finding the time; the height of the observer's eye being 18 feet, and the instruments adjusted.

Times by Chronometer on April 17.						
11^h	20^m	45^s	Alt. of ⊙'s L. L,	73°	$22'$	
11	22	20	Alt. of ☽'s U. L.,	12	28	
11	23	51	Distance,	65	30	$0''$
11	25	22	„ ,	65	28	30
11	26	50	„ ,	65	27	0
3)	76	3	3)		85	30
Means, 11	25	21		65	28	30
11	26	54	Alt. of ☽'s U. L.,	12	14	
11	28	25	Alt. of ⊙'s L L.,	71	50	

Answer. The true distance 65° 10′ 13″, thence the mean time at Greenwich, April 17, at $10^h\ 59^m\ 0^s$, and hence the error of the chronometer $26^m\ 21^s$ fast of Greenwich mean time. The mean time at the ship from the Sun's altitude, which was taken in the morning, April 16, at $20^h\ 2^m\ 19^s$; and the mean time at Greenwich, is April 17, at $5^h\ 57^m\ 59^s$, by applying the original error to the time by chronometer, or $5^h\ 57^m\ 58^s$, by using the error as found from the lunar observation; hence the longitude is 148° 55′ W., by chronometer, and 148° 54′ 45″ W., by lunar.

Note. By the Nautical Almanac, the Sun's declination is 10° 32′ 2″.7 N., on April 17, at noon, and 10° 53′ 1″.7 N., on April 18, at noon; also the Sun's semidiameter is 15′ 56″; and the equation of time is $0^m\ 29^s.52$, on April 17, at noon, and $0^m\ 43^s.43$, on April 18, at noon, subtractive from apparent time. The Moon's semidiameter is 15′ 18″.3, on April 17, at noon, and 15′ 24″.9 at midnight; also the corresponding parallaxes are 56′ 9″.8 and 56′ 34″.2. The true distance between the Sun and Moon, on April 17, is 66° 9′ 1″ at IX hours, and 64° 40′ 5″ at midnight, and the intermediate proportional logarithm is 3062.

6. On August 2, 1849, at noon, the error of a chronometer was ascertained to be $14^m\ 42^s$ fast of Greenwich mean time, and gaining $4^s.3$ daily. On September 10, in latitude 30° 10′ N., when the same chronometer showed $5^h\ 17^m\ 33^s$, (astronomical time), the distance between the nearest limbs of the Sun and Moon was observed, in order to ascertain the longitude, and found to be 77° 47′ 8″; but the altitudes could not be observed at that time, on account of the horizon being obscured. In the afternoon, on the same day, at $12^h\ 17^m\ 32^s$ by same chronometer, the altitude of the Sun's lower limb was observed, in order to ascertain the time at the ship, and found to be 27° 15′: the ship having sailed 15 miles due north between the observations. Required the true distance, and the error of the chronometer as deduced from it; also the longitude of the ship, both by the lunar observation, and the chronometer, when the Sun's altitude was taken in the afternoon for finding the time: the height of the observer's eye being 18 feet, and the instruments adjusted.

Answer. The mean time at ship, from Sun's altitude, is September 10, at $4^h\ 0^m\ 1^s$; hence the mean time at the ship, when the distance was observed, is September 9, at $21^h\ 0^m\ 3^s$; from which the apparent altitude of the Sun is found to be 41° 19′, and the apparent altitude of the Moon, 56° 6′. The true distance is 77° 51′ 6″, thence the mean time at Greenwich, September 10, at $4^h\ 59^m\ 45^s$, and hence the error of the chronometer, $17^m\ 48^s$ fast of Greenwich mean time. The mean time at Greenwich, when the Sun's altitude was observed, is September 10, at $12^h\ 0^m\ 0^s$ by applying the original error and rate to the time by chronometer, or $11^h\ 59^m\ 43^s$ by using the error as found from the lunar observation; hence the longitude is 119° 59′ 45″ W., by chronometer, and 119° 55′ 30″ W., by lunar.

Note. By the Nautical Almanac, the Sun's declination is 4° 53′ 40″.8 N. on September 10, at noon, and 4° 30′ 50″.9 N. on September 11, at noon; and the equation of time, for same dates, is $3^m\ 8^s.57$ and $3^m\ 29^s.28$, subtractive from apparent time; also the Sun's semidiameter is 15′ 55″. The Moon's semidiameter, on September 10, is 16′ 8″.9 at noon, and 16′ 9″.4 at midnight; also the corresponding parallaxes are 59′ 15″.7 and 59′ 17″.4; the Moon's right ascension on September 10, is $6^h\ 0^m\ 4^s.33$ at 5^h, and $6^h\ 2^m\ 34^s.26$ at 6^h, also the declinations, at same times, are 18° 45′ 38″.8 N., and 18° 47′ 3″.9 N.; the Sun's right ascension is $11^h\ 14^m\ 28^s.11$, at noon, on September 10, and $11^h\ 18^m\ 3^s.95$, at noon, on September 11. The true distance between the Sun and Moon, on September 10, is 78° 57′ 7″ at III hours, and 77° 17′ 53″ at VI hours, and the intermediate proportional logarithm is 2586.

7. On March 1, 1849, at noon, the error of a chronometer was ascertained to be $15^m\ 9^s$ slow of Greenwich mean time, and losing $3^s.8$ daily. On June 25, (astronomical time), when the same chronometer showed $17^h\ 36^m\ 40^s$, the distance between the fixed star Spica (Virginis) and the remote limb of the Moon was observed to be $32^0\ 10'\ 0''$, the altitude of Spica was $31^0\ 36'$, and the altitude of the Moon's upper limb was $30^0\ 26'$. On the same day, when the same chronometer showed $17^h\ 46^m\ 40^s$, the distance between the centre of the planet Jupiter, and the nearest limb of the Moon, was observed to be $28^0\ 48'\ 20''$, the altitude of Jupiter was $9^0\ 13''$, and the altitude of the Moon's upper limb was $28^0\ 30'$. On June 26, (civil time), in order to ascertain the time at the ship, the altitude of the Sun's lower limb was observed in the morning, when the same chronometer showed $5^h\ 26^m\ 53^s$ and was found to be $46^0\ 31'$, the ship being then in latitude $31^0\ 5'$ N. Required the true distance between the Moon and Spica, and also between the Moon and Jupiter, and the average error of the chronometer as deduced from these distances; also the longitude of the ship, both by the lunar observations and the chronometer, when the Sun's altitude was taken for finding the time: the height of the observer's eye being 18 feet, and the instruments adjusted.

Answer. The true distance between the Moon and Spica is $31^0\ 44'\ 54''$, hence the mean time at Greenwich, June 25, at $18^h\ 0^m\ 7^s$, and the error of the chronometer $23^m\ 27^s$ slow of Greenwich mean time; also the true distance between the Moon and Jupiter is $29^0\ 37'\ 18''$, hence the mean time at Greenwich, June 25, at $18^h\ 10^m\ 11^s$, and the error of the chronometer $23^m\ 31^s$ slow of Greenwich mean time; hence, when the Sun's altitude was taken, these errors are $23^m\ 29^s$ and $23^m\ 33^s$, and their average is $23^m\ 31^s$. The mean time at the ship from the Sun's altitude, is June 25, at $20^h\ 49^m\ 18^s$; and the mean time at Greenwich is June 26, at $5^h\ 49^m\ 27^s$ by applying the original error and rate to the time by chronometer, or June 26, at $5^h\ 50^m\ 24^s$ by using the average error, as found from the lunar observations; hence, the longitude is $135^0\ 2'\ 15''$ W., by chronometer, and $135^0\ 16'\ 30''$ W., by the lunars.

Note. By the Nautical Almanac, the Sun's declination is $23^0\ 22'\ 24''.2$ N., on June 26, at noon, and $23^0\ 20'\ 10''.4$ N., on June 27, at noon; and the equation of time is $2^m\ 26^s.67$ and $2^m\ 39^s.20$, additive to apparent time, at same dates. The Moon's semidiameter is $15'\ 38''.1$, on June 25, at midnight, and $15'\ 30''\ 8$, on June 26, at noon; and the corresponding horizontal parallaxes are $57'\ 22''.6$, and $56'\ 55''.7$. On June 25, the true distance between the Moon and Spica is $31^0\ 44'\ 58''$ at XVIII hours, and $30^0\ 8'\ 22''$ at XXI hours, and the intermediate proportional logarithm is 2703; and, at same hours, the true distances between the Moon and Jupiter are $29^0\ 31'\ 49''$ and $31^0\ 8'\ 41''$, and the intermediate proportional logarithm 2691.

THE TABLES.

EXPLANATION AND USE

OF

THE TABLES.

FEW of the Tables require any directions for using them, as the mode of taking out the quantities contained in them is evident by inspection; the following, however, may be noticed:—

TABLE III.

The Planet's Parallax may be ascertained from this Table, by looking for the degrees nearest to the given altitude in the side column, and for the seconds nearest to the horizontal parallax at the top; if the altitude is not found exactly in the side column, a proportional part for what it differs from the given altitude may be easily found by inspection; and the same regarding the horizontal parallax, or the horizontal parallax may be taken out in two parts, making up the given parallax, and the corresponding quantities in the table added.

Thus, to find the parallel in altitude for a Planet whose horizontal parallax is 24″, and altitude 25°; the Table gives, 9″ for altitude 20° and parallax 20′, and 17″ for altitude 30° and parallax 20′; hence it is 18″ for altitude 25° and parallax 20′; and it is 4″ for altitudes 24° and parallax 4′; therefore, by adding these, we obtain 22″, for altitude 24° and parallax 24′.

The parallax in altitude may also be found by taking it from the Tables corresponding to the given altitude, and horizontal parallax 10′; multiplying this by the given horizontal parallax, and cutting off the last figure. Thus, the Table gives 9″ for altitude 24° and horizontal parallax 10′; hence, for horizontal parallax 24″ we multiply 9″ by 24, which gives 216″, and cutting off the last figure, we obtain 21″.6, or 22″.

By means of a Table of Difference of Latitude and Departure, we may find it as a Difference of Latitude corresponding to the horizontal parallax taken as a Distance, and the altitude as a Course. Thus, under Course 24°, and opposite Distance 24″, we find in the Difference of Latitude column 21″.8, or 22″.

TABLES IV. AND IV.*

Table IV. contains the Refraction, corresponding to the mean temperature and density of the atmosphere, or for the temperature 50°, and height of the barometer 29.6 inches, and may be easily found for any altitude by inspection of the Table: the Refraction is always subtractive from the apparent altitude to obtain the true altitude.

The corrections of the Mean Refraction, for any given heights of the Barometer and Thermometer, are easily

found from Table IV.* Thus, let the apparent altitude be 1°, the height of the thermometer 95°, and that of the barometer 30.0 inches: required the Refraction.

Mean Refraction, by Table IV., to altitude 1°, ...			24′ 28″
Correction, by Table IV*., for Therm. 95°, and Ref. 20′.....	— 122″		
" " " , " 95°, and Ref. 4′.....	24		
" " " , " 95°, and Ref. 30″ ...	2		
	—	— 148″	
" " " , for Barom. 30.0, and Ref. 20′.....	+ 14″		
" " " , " 30.0, and Ref. 4′	3		
" " " , " 30.0, and Ref. 30″	0		
	—	+ 17	
		— 131	= — 2 11
Refraction required, . . .			22 17

In the above, the correction for Thermometer 95° and Refraction 20′ is stated at — 122″, and is thus found: the correction opposite 92° is 114″

96° is 124

4 0

Hence, if 4° gives 10″, 3° gives 8″, (by proportion,)

and correction for 92° is 114

therefore correction for 95° is 122

To find the correction for height of Barometer 30.0 inches, and Refraction 20′, we find the correction opposite to . . . . . 29.8 is 6″

30.1 is 18

.3 is 12

Hence, if .3 gives 12″, .2 gives 8″

and correction for 29.8 is 6

therefore, correction for 30.0 is 14

TABLE V.

This Table contains an Auxiliary Arc used as an Argument for Table VI.; it may always be taken out sufficiently correct by looking for the nearest degrees and minutes to the less altitude at the top of the Table, and the nearest to the greater apparent altitude in the side column: below the former, and opposite to the latter, will be found the correction required. If greater accuracy be required, the exact correction may be easily proportioned for.

Thus, if the altitudes are 42° 42′ and 7° 4′: required the auxiliary arc. The nearest altitudes, in the Table, to those given are 42° 30′ and 7° 5′, which gives the correction = 196″; or we may proportion thus:—

Correction for greater altitude 42° 30′ and less altitude 7° 0′ is	199″
Proportional part for 12′ of greater altitude . . . is	+1
" " 4′ of less altitude . . . is	—2
	198

The proportional parts in the above are found thus:—

Correction for greater altitude 42° 30′ and less altitude 7° 0′ is	199″
43° 0′ " 7° 0′ is	202
Difference for 30′ altitude is	+3

If 30′ gives + 3″, 12′ gives + 1″.

Again, the correction for greater altitude 42° 30′ and less altitude 7° 0′ is 199″
" and " 7° 5′ is 196

Difference for 5′ altitude is — 3″

If 5′ gives — 3″, 4′ gives — 2″.

The proportional parts for minutes of altitude may be found by means of the following Tables: where the difference between the corrections for two altitudes which follow each other in the Table are given at the top; and opposite to the minutes of altitude in the side column will be found the proportional parts for them, to be applied to the correction taken out of the Table for the altitude found in it next less than the given one, by addition or subtraction, according as the correction is increasing or diminishing.

P.P. for Alt.	Diff. for 5′ of Alt.					P.P for Alt.	Diff. for 10′ of Alt.		
	1″	2″	3″	4″	5″		1″	2″	3″
′	″	″	″	″	″	′	″	″	″
1	0.2	0.4	0.6	0.8	1.0	1	0.1	0.2	0.3
2	0.4	0.8	1.2	1.6	2.0	2	0.2	0.4	0.6
3	0.6	1.2	1.8	2.4	3.0	4	0.4	0.8	1.2
4	0.8	1.6	2.4	3.2	4.0	6	0.6	1.2	1.8
						8	0.8	1.6	2.4

P.P. for Alt.	Diff. for 30′ of Alt.				P.P. for Alt.	Diff. for 1° of Alt.					
	1″	2″	3″	4″		1″	2″	3″	4″	5″	6″
′	″	″	″	″	′	″	″	″	″	″	″
1	0.0	0.0	0.1	0.1	1	0.0	0.0	0.0	0.1	0.1	0.1
5	0.2	0.3	0.5	0.7	10	0.1	0.3	0.5	0.7	0.8	1.0
10	0.3	0.7	1.0	1.3	20	0.3	0.7	1.0	1.3	1.7	2.0
15	0.5	1.0	1.5	2.0	30	0.5	1.0	1.5	2.0	2.5	3.0
20	0.7	1.3	2.0	2.7	40	0.6	1.4	2.0	2.7	3.3	4.0
25	0.8	1.7	2.5	3.3	50	0.8	1.7	2.5	3.3	4.2	5.0

TABLE VI.

This Table contains the correction of the distance for refraction + 20″, and is always additive to the apparent distance. The upper part of the Table contains the correction for 0″ to 50″ of the Auxiliary Arc from Table V.; and from the lower part, which is separated from the upper by a double line, the correction may be found from 50″ to 300″, thus:—If the Arc, Table V., is exactly found in the lower part of the Table, take the corresponding correction, and add to it the correction opposite 0″ in the upper part; if the Arc, Table V., is not found exactly in the lower part of the Table, take the correction for the next less arc, and add to it the correction for the remaining seconds of the auxiliary arc taken from the upper part of the Table.

Thus, if the apparent distance is 119°, required the corrections corresponding respectively to the auxiliary arcs 25″, 60″, and 237″, from Table V. Under 119°, and opposite to 25″, in the upper part of the Table, the correction is at once fonnd to be 4′ 2″; under 119°, and opposite to 60″, the correction, in the lower part of the Table, is found to be . . . . . 1′ 9″
to which add the correction, from the upper part, opposite to 0″, ... 3 34

Correction for 60″, ... 4 43

Again the correction, in the lower part, opposite to 200″ is 3′ 49″
And the correction, in the upper part, opposite to 37 is 4 16

Correction for 237 is 8 5

If the apparent distance is not found exactly at the top, it will be sufficiently exact to take the correction for the distance in the Table, which is nearest to the given distance: if greater accuracy is required, the necessary proportions are easily made.

Thus, if the apparent distance is 119° 25′, and the auxiliary arc, from Table V., = 270″: required the correction.

Correction for distance 119°, and auxiliary arc 250″, from lower part of Table, . . 4′ 46″
Distance 120°, and arc 250″, give 4′ 49″; hence if 1° or 60′ in distance gives 3″, then 25′ gives 0 1
Correction for distance 119°, and auxiliary arc 20″, from upper part, ... 3 56
Distance 120°, and arc 20″, give 4′ 1″; hence if 1° or 60′ in distance gives 5″, then 25′ gives 0 2

Correction for distance 119° 25′ and auxiliary arc 270″, = 8′ 45″

The proportional part for minutes of distance may be found from the following Table:—

P.P. for Dist.	Difference for 1° of Distance.																			
	1″	2″	4″	6″	8″	10″	12″	14″	16″	18″	20″	22″	24″	26″	28″	30″	32″	34″	36″	38″	40″
′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
1	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7
2	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.3	1.3
3	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
4	0.1	0.1	0.3	0.4	0.5	0.7	0.8	0.9	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0	2.1	2.2	2.4	2.5	2.7
5	0.1	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.7	1.8	2.0	2.2	2.3	2.5	2.7	2.8	3.0	3.2	3.3
10	0.2	0.3	0.7	1.0	1.3	1.7	2.0	2.3	2.7	3.0	3.3	3.7	4.0	4.3	4.7	5.0	5.3	5.7	6.0	6.3	6.7
15	0.3	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
20	0.3	0.7	1.3	2.0	2.7	3.3	4.0	4.7	5.3	6.0	6.7	7.3	8.0	8.7	9.3	10.0	10.7	11.3	12.0	12.7	13.3
25	0.4	0.8	1.7	2.5	3.3	4.2	5.0	5.8	6.7	7.5	8.3	9.2	10.0	10.8	11.7	12.5	13.3	14.2	15.0	15.8	16.7
30	0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
35	0.6	1.2	2.3	3.5	4.7	5.8	7.0	8.2	9.3	10.5	11.7	12.9	14.0	15.2	16.3	17.5	18.7	19.8	21.0	22.2	23.3
40	0.7	1.3	2.7	4.0	5.3	6.7	8.0	9.3	10.7	12.0	13.3	14.7	16.0	17.3	18.7	20.0	21.3	22.7	24.0	25.3	26.7
45	0.8	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
50	0.8	1.7	3.3	5.0	6.7	8.3	10.0	11.7	13.3	15.0	16.7	18.3	20.0	21.7	23.3	25.0	26.7	28.3	30.0	31.7	33.3
55	0.9	1.8	3.7	5.5	7.3	9.2	11.0	12.8	14.7	16.5	18.3	20.3	22.0	23.8	25.7	27.5	29.3	31.2	33.0	34.8	36.7

TABLE VII.

The correction from this Table is always additive to the apparent distance, being the correction of the distance for horizontal parallax 10′, increased by 10′; and may therefore be assumed as sufficiently correct for the Sun, as the Sun's horizontal parallax is 9′; the correction for the Sun may, however, be found correctly by taking the correction from the Table, and diminishing it by one-tenth of itself.

Thus, if the apparent distance is 42° 15′, the Sun's altitude 37°, and the Moon's altitude 18°: required the Sun's correction.

The nearest quantities in the Table to those given are, distance 40°, Sun's altitude 40°, and Moon's altitude 20°, which gives the correction 12′′: or, deducting from 12′′ one-tenth of 12′′ or 1′′, we have the correction more accurately = 11′′.

As the corrections in this Table vary but inconsiderably, it is needless to proportionate in order to find the correction precisely; if such proportioning was made, it would require to be performed for the differences betwixt the altitude of the Sun, the altitude of the Moon, and the apparent distance, as found in the Table, and those given.

To find the correction for a Planet: take the correction from the Table, multiply it by the horizontal parallax of the Planet, and cut off the last figure.

TABLE X.

This Table contains the Proportional Logarithms for 3 hours or degrees, and is useful in solving proportions having one of the terms 3 hours or degrees.

The general rule for solving a proportion by logarithms is to add the logarithms of the second and third terms, and from their sum subtract the logarithm of the first term, the remainder is the logarithm of the fourth term. Hence, as the proportional logarithm of 3 hours is 0, if the first term of a proportion is 3 hours, add the proportional logarithms of the second and third terms, the sum is the proportional logarithm of the fourth term.

If either of the middle terms (second or third) is 3 hours, from the proportional logarithms of the other

middle term subtract the proportional logarithm of the first term, the remainder is the proportional logarithm of the fourth term. If none of the terms of a proportion is 3 hours, proceed as with common logarithms; but it must be observed that this Table is only applicable when all the terms of a proportion are less than 3 hours.

EXAMPLE I.

To find the fourth term of the following proportion; 3^h : 2^h 14′ 20″ :: 12′ 14″:

2^h 14′ 20″	P. Log.	1271
12′ 14″	P. Log.	1.1677
4th term 9′ 8″	P. Log.	1.2948

EXAMPLE II.

To find the fourth term of the proportion: 2^h 14′ 20″ : 3^h :: 9′ 8″:

9′ 8″	P. Log.	1.2946
2^h 14′ 20″	P. Log.	1271
4th term 12′ 14″	P. Log.	1.1675

TABLE XI.

This Table may be used for converting space into time, and the contrary: 15° being equivalent to 1 hour.

The numbers in the first column of the several parts of the Table may be taken as degrees, minutes, or seconds, and respectively corresponding to these in the second column will be found hours and minutes, minutes and seconds, or seconds and thirds, agreeably to the titles in the Table.

Thus, to convert 140° 20′ 15″ into time:

140°	gives	9^h 20′	0″
20′	"	1	20
15″	"		1
		9 21	21

Or, space may be converted into time by reckoning degrees, minutes, and seconds respectively as minutes, seconds, and thirds, and multiplying the results by 4:

Thus, for 140° 20′ 15″ write 140′ 20″ 15‴, or 2^h 20′ 20″ 15‴

				4
9	21	21		0

Again, let it be required to convert 9^h 21′ 21″ into space:

Given, . .	9^h	21′	21″	
Nearest in the Table,	9	20	0	
				= 140°
	0	1	21	
Nearest in the Table,	0	1	20	
				= 20′
	0	0	1	
By the Table,	0	0	1	
				= 15″
				140° 20′ 15″

Or, time may be converted into space, by reckoning minutes and seconds respectively as hours and minutes, and dividing the result by 4: Thus, for 9^h 21′ 21″

60

or 561′ 21″, write 561° 21′
divided by 4 gives 140° 20′ 15″

TABLE XIII.

This Table contains the correction of the Sun's declination for any given Greenwich time. And to find the declination, take out the declination from the Nautical Almanac for the nearest noon to the given time, and find the correction for the number of hours betwixt this noon and the given time; which, when the given time is after noon, is additive or subtractive from the declination at noon, according as the declination is increasing or diminishing; but, when the given time is before noon, the correction is subtractive or additive according as the declination is increasing or decreasing.

TABLE XIV.

This Table contains the correction of the equation of time, and is applied similarly to the correction in Table XIII.

TABLE XV.

This Table contains the sum of the dip and refraction, and is therefore always subtractive from the apparent altitude.

TABLE XVI.

This Table contains 16′ as the semi-diameter of the Sun, diminished by the sum of the refraction and dip, and increased by the parallax in altitude.

TABLE XVIII.

This Table, containing the logarithms of the meridian distance, being the time from noon, is easily used. Near the beginning of the Table the logarithms vary considerably, and we must therefore proportion to obtain the correct logarithm for any time which is not found exactly in the Table.

Thus, to find the logarithm for 0^h 19′ 3″: the logarithm for 0^h 19′ 0″ is 7.2348, and the tabular difference is 38 (= 2386 — 2348), hence 5″ : 3″ :: 38 : . . . 23

0^h 19′ 3″ logarithm 7.2371

Or, if we take the tabular difference for 10″, we may easily find the difference for the given seconds, by multiplying this tabular difference by the number of seconds, and cutting off the last figure, thus:—

0^h 19′ 0″ logarithm 7.2348

Tabular difference for 10″ = (2424 — 2348 =) 76
Number of seconds, . . . 3

22.8 . . . 23

0^h 19′ 3″ logarithm 7.2371

Again, when a logarithm is given, to find the exact time: take out the next less logarithm, and the corresponding time; from the given logarithm subtract this logarithm, annex a cypher to the remainder, and divide by the tabular difference for 10″, which will give the seconds to be added to the time already taken from the Table. Thus, if the given logarithm is 7.2371
then the next less in the Table is 0^h 19′ 0″, Logarithm 48

Tabular difference for 10″ = 76) 230 (3′
228

Hence the required time is 0^h 19′ 3″.

In the greater part of the Table, however, it is sufficiently accurate to take the nearest logarithms in the Table, or the proportioning may be performed mentally.

TABLE XIX.

This Table contains proportional logarithms for 24 degrees or hours, and is useful for solving a proportion having one of its terms 24 hours: it is used similarly to proportional logarithms for 3 hours, Table X. By this Table, the proportional part, for any given time after noon, of the daily change of the Sun's declination, may be found; and the same of any element which is given in the Nautical Almanac for every day at noon. The numbers at the head of the columns may be considered either as degrees, or hours, or minutes, and those in the side columns must then be taken respectively as minutes, or seconds.

To find the proportional part of the daily variations of the Sun's declination for any given Greenwich time after noon: Add together the proportional logarithms of the given time and of the daily variation (taking the minutes at the top, and the seconds in the left hand column), the sum is the proportional logarithm of the proportional part required, the minutes and seconds being taken out of the Table in the same way as the daily variation; this proportional part added to, or subtracted from, the declination at noon, according as the declination is increasing or decreasing, will give the declination for the given time. Proceed similarly for the Sun's right ascension, or any other element which is given for noon in the Almanac.

EXAMPLE I.

Required the Sun's declination and right ascension on September 10th, 1849, at 14^h 34′ mean time at Greenwich.

Sun's declination, Sept. 10, by page II. of Nautical Almanac,	4°	53′	41″	N.	
Ditto, Sept. 11, by ditto,	4	30	51	N.	
Daily variation, (decreasing)	0	22	50	P. L.	0216
Greenwich mean time, ...	14^h	34′	0″	P. L.	2168
Variation in 14^h 34′	— 0°	13′	52″	P. L.	2384
Sun's declination, Sept. 10, by page II. of Nautical Almanac,	4	53	41	N.	
Ditto, at given time, ...	4	39	49	N.	
Sun's right ascension, Sept. 10, by page II. of Nautical Alm.	11^h	14′	28″		
Ditto, Sept. 11, by ditto,	11	18	4		
Daily variation, (increasing)	0	3	36	P. L.	8239
Greenwich mean time, ...	14^h	34′	0″	P. L.	2168
Variation in 14^h 34′	+ 0^h	2′	11″	P. L.	1.0407
Sun's right ascension, Sept. 10, by page II. of Nautical Alm.	11	14′	28″		
Ditto, at given time, ...	11	16	39		

EXAMPLE II.

Required the right ascension and declination of the planet Jupiter, on April 20th, 1849, at 10^h 39′ mean time at Greenwich.

Jupiter's right ascension, April 20, by page 391, Nautical Alm.,	9^h	1′	59″		
Ditto, April 21, by ditto,	9	2	8		
Daily variation, (increasing)	0	0	9	P. L.	2.2041
Greenwich mean time,	10	39	0	P. L.	3529
Variation in 10^h 39′	+ 0°	0′	4″	P. L.	2.5570
Jupiter's right ascension, April 20, by page 391, Nautical Alm.,	9	1	59		
Ditto, at given time,	9	2	3		

Jupiter's declination, April 20, by page 391, Nautical Almanac,	17°	55′	59″ N.		
Ditto, April 21, by ditto,	17	55	13		
Daily variation, (decreasing)	0	0	46	P. L.	1.4956
Greenwich mean time,	10^h	39′	0″	P. L.	3529
Variation in 10^h 39′	— 0°	0′	20″	P. L.	1.8485
Jupiter's declination, April 20, by page 391, Nautical Almanac,	17	55	59 N.		
Ditto, at given time,	17	55	39 N.		

If the declination at the noon from which the given time is reckoned is of a different name from that at the following noon, we must take the sum of these declinations for the daily variation. And take the difference between the first declination and the proportional part of the daily variation, found as formerly, the result is the required declination; it is of the same name as the first declination, or of a contrary name, according as the proportional part of the daily variation is less or greater than the first declination.

TABLE XXI.

This Table contains proportional logarithms for 1 degree or hour, and is useful for solving a proportion having one of its terms 1 degree or hour. It is used similarly to proportional logarithms for 3 hours, Table X., and those for 1 hour, Table XIX.

By this Table, the declination and right ascension of the Moon may be found for any given time at Greenwich.

To find the Moon's declination or right ascension for any given time at Greenwich: take them from the Nautical Almanac for the hours of the given time, and for the next following hour, the difference between which is the hourly variation; then add together its proportional logarithm, and the proportional logarithm of the minutes and seconds of the given time, the sum is the proportional logarithm of the variation for these; which being added to or subtracted from the declination or ascension first taken from the Almanac, according as the daily variation is increasing or decreasing, will give that required corresponding to the given time.

EXAMPLE I.

Required the Moon's declination, and right ascension, for April 10, 1849, at $16^h\ 20'\ 14''$ mean time at Greenwich.

Moon's declination, April 10, at 16^h by page VI. Nautical Alm.,		$15°$	$17'$	$49''$ S.	
Ditto , at 17^h by ditto,		15	23	20	
Variation in 1 hour,	+	0	5	31	P. L. 1.0365
Greenwich mean time after 16^h		0	20	14	P. L. 4721
Variation in $20'\ 14''$,	+	$0°$	$1'$	$52''$	P. L. 1.5086
Moon's declination, April 10, at 16^h		15	17	49 S.	
Ditto, at given time,		15	19	41 S.	

Moon's right ascension, April 10, at 16^h by page VI. Naut. Alm.		15^h	$57'$	$18''$	
Ditto , at 17^h by ditto,		15	59	19	
Variation in 1 hour,	+	0	2	1	P. L. 1.4735
Greenwich mean time after 16^h		0	20	14	P. L. 4721
Variation in $20'\ 14''$,	+	0^h	$0'$	$41''$	P. L. 1.9456
Moon's right ascension, April 10, at 16^h		15	57	18	
Ditto at given time,		15	57	59	

EXAMPLE II.

Required the Moon's declination, and right ascension, May 18, 1849, at $0^h\ 30'\ 14''$ at Greenwich mean time.

Moon's declination, May 18, at 0^h, by page IX. Nautical Alm.		$0°$	$6'$	$31''$ S.	
Ditto, at 1^h, by ditto,		0	4	45 N.	
Variation in 1 hour,	—	0	11	16	P. L. 7264
Greenwich mean time after 0^h		0	30	14	P. L. 2977
Variation in $30'\ 14''$	—	$0°$	$5'$	$41''$	P. L. 1.0241
Moon's declination, May 18, at 0^h,		0	6	31 S.	
Ditto, at given time,		0	0	50 S.	

Moon's right ascension, May 18, at 0^h, by page IX. Naut. Alm.		0^h	$21'$	$18''$	
Ditto, May 18, at 1^h, by ditto,		0	23	30	
Variation in 1 hour,	+	0	2	12	P. L. 1.4357
Greenwich mean time after 0^h		0	30	14	P. L. 2977
Variation in $30'\ 14''$	+	0^h	$1'$	$7''$	P. L. 1.7334
Moon's right ascension, May 18, at 0^h		0	21	18	
Ditto, at given time,		0	22	25	

TABLE XXVII.

This Table contains what is called the Luni-Solar Equation, which is used in Methods IV. and V.: a specimen only of the Table is given, extending from 20° to 30° of Moon's altitude.

The equation is found in the Table for the minutes of the Moon's horizontal parallax at the top, and every 10′ of altitude in the side column: for seconds of parallax add a proportional part taken from the Table at the right hand side of the page; and add, for the minutes of Moon's altitude not found in the Table, a number of seconds taken from one of the small Tables at the left hand side of the page; lastly, for the Sun or Star, add a number of seconds taken from the bottom of the page.

Thus, to find the Luni-Solar Equation for Moon's altitude 23° 47′, horizontal parallax 54′ 23″, and Sun's altitude 27°.

Luni-Solar Equation for ☾'s altitude 23° 40′, parallax 54′ . .	20′ 6″
Correction for parallax 23″ . .	+ 10
" for ☾'s alt. 7′ . .	6
" for ☉'s alt. 27° . .	5
Equation required, ...	20′ 27″

TABLE XXVIII.

This Table contains the Natural Numbers, being the lengths of Arcs to the radius 1,000,000: the last five figures only being retained.

The natural number is taken from the left hand or right hand part of the Table, according as the Arc is E. or W., that is, positive or negative: the proportional parts for seconds are given at the right hand side of each part of the Table.

EXAMPLE I.:—Required the Natural Number for the Arc 1° 59′ 12″ E.

1° 59′	Nat. No.	34616
12″	P. P.	58
1° 59′ 12″	Nat. No.	34674

EXAMPLE II.—Required the Natural Number for the Arc 1° 24′ 50″ W.

1° 24′	Nat. No.	74565
50″	P. P.	758
1° 24′ 50″	Nat. No.	75323

LUNAR TABLES.

TABLE I.

Departure of the Moon in Altitude:—*Add to Altitude.*

☽'s App. Alt.	Moon's Horizontal Parallax.										☽'s App. Alt.	Moon's Horizontal Parallax.									
	53′	54′	55′	56′	57′	58′	59′	60′	61′	62′		53′	54′	55′	56′	57′	58′	59′	60′	61′	62′
°	′	′	′	′	′	′	′	′	′	′	°	′	′	′	′	′	′	′	′	′	′
7	19	19	20	20	21	21	22	22	23	23	46	18	18	18	19	19	19	20	20	20	21
8	20	20	21	21	22	22	23	23	24	24	48	17	17	18	18	18	19	19	19	20	20
10	21	21	22	22	23	23	24	24	25	25	50	16	17	17	17	18	18	18	19	19	19
12	22	22	23	23	24	24	24	25	25	26	52	16	16	16	17	17	17	17	18	18	18
14	22	23	23	24	24	24	25	25	26	26	54	15	15	15	16	16	16	17	17	17	18
16	22	23	23	24	24	25	25	26	26	27	56	14	15	15	15	15	16	16	16	16	17
18	22	23	23	24	24	25	25	26	26	27	58	14	14	14	14	15	15	15	15	16	16
20	22	23	23	24	24	25	25	26	26	27	60	13	13	13	13	14	14	14	14	15	15
22	22	23	23	24	24	25	25	26	26	27	62	12	12	12	13	13	13	13	14	14	14
24	22	23	23	23	24	24	25	25	26	26	64	11	11	12	12	12	12	12	13	13	13
26	22	22	23	23	24	24	25	25	26	26	66	10	11	11	11	11	11	12	12	12	12
28	22	22	23	23	23	24	24	25	25	26	68	10	10	10	10	10	10	11	11	11	11
30	21	22	22	23	23	23	24	24	25	25	70	9	9	9	9	9	10	10	10	10	10
32	21	21	22	22	23	23	24	24	24	25	72	8	8	8	8	8	9	9	9	9	9
34	21	21	21	22	22	23	23	23	24	24	74	7	7	7	7	8	8	8	8	8	8
36	20	21	21	21	22	22	23	23	23	24	76	6	6	7	7	7	7	7	7	7	7
38	20	20	20	21	21	22	22	22	23	23	78	5	5	6	6	6	6	6	6	6	6
40	19	20	20	20	21	21	21	22	22	22	82	4	4	4	4	4	4	4	4	4	4
42	19	19	19	20	20	21	21	21	22	22	86	2	2	2	2	2	2	2	2	2	2
44	18	18	19	19	20	20	20	21	21	21	90	0	0	0	0	0	0	0	0	0	0

TABLE II.

Corrections for the Spheroidal Figure of the Earth.

Correction of Altitude.

Latitude	Azimuth: *Add Correction.*															Latitude	Reduction of ☽'s Hor. Par.	
	0°	10°	20°	30°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°		Lat.	Red.
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°	°	″
0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	90		
5	3	3	2	2	2	2	2	1	1	1	1	1	0	0	0	85	10	1
10	4	4	3	3	3	3	3	2	2	2	1	1	1	0	0	80	20	2
15	6	6	5	5	5	4	4	3	3	2	2	1	1	0	0	75	30	4
20	8	8	7	7	7	5	5	4	4	3	2	2	1	1	0	70	40	6
30	10	10	10	9	8	7	6	6	5	4	3	2	1	1	0	60	50	8
40	11	11	11	10	9	8	7	7	6	5	4	3	2	1	0	50	60	11
45	12	11	11	10	9	8	8	7	6	5	4	3	2	1	0	45	70	13
Latitude	180°	170°	160°	150°	140°	135°	130°	125°	120°	115°	110°	105°	100°	95°	90°	Latitude	80	14
	Azimuth: *Subtract Correction.*																90	15

TABLE III.

Containing:—Augmentation of ☽'s Semi-diameter; Dip of Horizon; and Parallax in Altitude of the Sun and Planets.

☽'s Aug.		Dip of Horizon.						☉'s Par.		Planet's Parallax.								
Alt.	Aug.	Ht. in Feet.	Dip.	Ht. in Feet.	Dip.	Ht. in Feet.	Dip.	Alt.	Par.	Altitude.	Horizontal Parallax.							
											1″	2″	4″	6″	8″	10″	20″	30′
°	″		′ ″		′ ″		′ ″	°	″	°	″	″	″	″	′	″	″	″
0	0	1	0 58	15	3 42	25	4 47	0	9									
10	3	2	1 21	16	3 50	26	4 52	10	9	10	1	2	4	6	8	10	20	30
20	6	4	1 56	17	3 57	30	5 15	20	8	20	1	2	4	6	8	9	19	28
30	8	6	2 21	18	4 4	40	6 2	30	8	30	1	2	4	5	7	9	17	26
40	10	8	2 24	19	4 11	50	6 46	40	7	40	1	2	3	5	6	8	15	23
50	12	10	3 2	20	4 17	60	7 25	50	6	50	1	1	3	4	5	7	13	20
60	14	11	3 10	21	4 23	70	8 1	60	4	60	0	1	2	3	4	5	10	15
70	15	12	3 19	22	4 30	80	8 34	70	3	70	0	1	2	2	3	4	7	10
80	15	13	3 27	23	4 36	90	9 6	80	2	80	0	0	1	1	2	2	4	5
90	16	14	3 36	24	4 42	100	9 35	90	0	90	0	0	0	0	0	0	0	0

TABLE IV.

Mean Refraction.

For Height of Barometer 29.6 inches, and Thermometer 50°.

Alt.	Ref	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.
° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″
0 0	33 0	1 0	24 28	2 20	17 4	4 20	11 8	6 20	8 3	8 20	6 15	10 20	5 5	12 50	4 6		
0 1	32 50	1 1	24 21	2 22	16 56	4 22	11 4	6 22	8 1	8 22	6 14	10 22	5 4	12 55	4 5		
0 2	32 40	1 2	24 14	2 24	16 48	4 24	11 0	6 24	7 58	8 24	6 12	10 24	5 3	13 0	4 3		
0 3	32 30	1 3	24 8	2 26	16 40	4 26	10 56	6 26	7 56	8 26	6 11	10 26	5 2	13 5	4 2		
0 4	32 20	1 4	24 1	2 28	16 32	4 28	10 52	6 28	7 53	8 28	6 9	10 28	5 1	13 10	4 0		
0 5	32 10	1 5	23 54	2 30	16 24	4 30	10 48	6 30	7 51	8 30	6 8	10 30	5 0	13 15	3 59		
0 6	32 0	1 6	23 47	2 32	16 16	4 32	10 44	6 32	7 49	8 32	6 7	10 32	4 59	13 20	3 57		
0 7	31 51	1 7	23 40	2 34	16 8	4 34	10 40	6 34	7 47	8 34	6 5	10 34	4 58	13 25	3 56		
0 8	31 41	1 8	23 33	2 36	16 1	4 36	10 37	6 36	7 44	8 36	6 4	10 36	4 58	13 30	3 54		
0 9	31 32	1 9	23 27	2 38	15 53	4 38	10 33	6 38	7 42	8 38	6 2	10 38	4 57	13 35	3 53		
0 10	31 22	1 10	23 20	2 40	15 45	4 40	10 29	6 40	7 40	8 40	6 1	10 40	4 56	13 40	3 51		
0 11	31 13	1 11	23 14	2 42	15 38	4 42	10 25	6 42	7 38	8 42	6 0	10 42	4 55	13 45	3 50		
0 12	31 3	1 12	23 7	2 44	15 31	4 44	10 22	6 44	7 36	8 44	5 59	10 44	4 54	13 50	3 48		
0 13	30 54	1 13	23 1	2 46	15 23	4 46	10 18	6 46	7 34	8 46	5 57	10 46	4 53	13 55	3 47		
0 14	30 44	1 14	22 54	2 48	15 16	4 48	10 14	6 48	7 32	8 48	5 56	10 48	4 52	14 0	3 45		
0 15	30 35	1 15	22 47	2 50	15 9	4 50	10 11	6 50	7 30	8 50	5 55	10 50	4 51	14 5	3 44		
0 16	30 26	1 16	22 41	2 52	15 3	4 52	10 8	6 52	7 28	8 52	5 54	10 52	4 50	14 10	3 43		
0 17	30 17	1 17	22 34	2 54	14 56	4 54	10 4	6 54	7 26	8 54	5 52	10 54	4 49	14 15	3 42		
0 18	30 7	1 18	22 28	2 56	14 50	4 56	10 1	6 56	7 24	8 56	5 51	10 56	4 49	14 20	3 40		
0 19	29 58	1 19	22 21	2 58	14 43	4 58	9 57	6 58	7 22	8 58	5 49	10 58	4 48	14 25	3 39		
0 20	29 49	1 20	22 15	3 0	14 36	5 0	9 54	7 0	7 20	9 0	5 48	11 0	4 47	14 30	3 38		
0 21	29 40	1 21	22 9	3 2	14 30	5 2	9 51	7 2	7 18	9 2	5 47	11 2	4 46	14 35	3 37		
0 22	29 31	1 22	22 3	3 4	14 23	5 4	9 48	7 4	7 16	9 4	5 46	11 4	4 45	14 40	3 35		
0 23	29 23	1 23	21 56	3 6	14 17	5 6	9 44	7 6	7 15	9 6	5 44	11 6	4 45	14 45	3 34		
0 24	29 14	1 24	21 50	3 8	14 10	5 8	9 41	7 8	7 13	9 8	5 43	11 8	4 44	14 50	3 33		
0 25	29 5	1 25	21 44	3 10	14 4	5 10	9 38	7 10	7 11	9 10	5 42	11 10	4 43	14 55	3 32		
0 26	28 56	1 26	21 38	3 12	13 58	5 12	9 35	7 12	7 9	9 12	5 41	11 12	4 42	15 0	3 30		
0 27	28 48	1 27	21 32	3 14	13 52	5 14	9 32	7 14	7 7	9 14	5 40	11 14	4 41	15 5	3 29		
0 28	28 39	1 28	21 27	3 16	13 46	5 16	9 29	7 16	7 6	9 16	5 38	11 16	4 41	15 10	3 28		
0 29	28 31	1 29	21 21	3 18	13 40	5 18	9 26	7 18	7 4	9 18	5 37	11 18	4 40	15 15	3 27		
0 30	28 22	1 30	21 15	3 20	13 34	5 20	9 23	7 20	7 2	9 20	5 36	11 20	4 39	15 20	3 26		
0 31	28 14	1 31	21 9	3 22	13 28	5 22	9 20	7 22	7 0	9 22	5 35	11 22	4 38	15 25	3 25		
0 32	28 5	1 32	21 3	3 24	13 23	5 24	9 17	7 24	6 58	9 24	5 34	11 24	4 37	15 30	3 24		
0 33	27 57	1 33	20 58	3 26	13 17	5 26	9 14	7 26	6 57	9 26	5 33	11 26	4 37	15 35	3 23		
0 34	27 48	1 34	20 52	3 28	13 12	5 28	9 11	7 28	6 55	9 28	5 32	11 28	4 36	15 40	3 21		
0 35	27 40	1 35	20 46	3 30	13 6	5 30	9 8	7 30	6 53	9 30	5 31	11 30	4 35	15 45	3 20		
0 36	27 32	1 36	20 41	3 32	13 1	5 32	9 5	7 32	6 51	9 32	5 30	11 32	4 34	15 50	3 19		
0 37	27 24	1 37	20 35	3 34	12 56	5 34	9 2	7 34	6 50	9 34	5 29	11 34	4 33	15 55	3 18		
0 38	27 15	1 38	20 30	3 36	12 50	5 36	9 0	7 36	6 48	9 36	5 27	11 36	4 33	16 0	3 17		
0 39	27 7	1 39	20 24	3 38	12 45	5 38	8 57	7 38	6 47	9 38	5 26	11 38	4 32	16 5	3 16		
0 40	26 59	1 40	20 18	3 40	12 40	5 40	8 54	7 40	6 45	9 40	5 25	11 40	4 31	16 10	3 15		
0 41	26 51	1 42	20 7	3 42	12 35	5 42	8 51	7 42	6 43	9 42	5 24	11 42	4 30	16 15	3 14		
0 42	26 43	1 44	19 57	3 44	12 30	5 44	8 49	7 44	6 42	9 44	5 23	11 44	4 29	16 20	3 13		
0 43	26 36	1 46	19 46	3 46	12 25	5 46	8 46	7 46	6 40	9 46	5 22	11 46	4 29	16 25	3 12		
0 44	26 28	1 48	19 36	3 48	12 20	5 48	8 44	7 48	6 39	9 48	5 21	11 48	4 28	16 30	3 11		
0 45	26 20	1 50	19 25	3 50	12 15	5 50	8 41	7 50	6 37	9 50	5 20	11 50	4 27	16 35	3 10		
0 46	26 12	1 52	19 15	3 52	12 10	5 52	8 39	7 52	6 35	9 52	5 19	11 52	4 26	16 40	3 9		
0 47	26 5	1 54	19 5	3 54	12 5	5 54	8 36	7 54	6 34	9 54	5 18	11 54	4 25	16 45	3 8		
0 48	25 57	1 56	18 55	3 56	12 1	5 56	8 33	7 56	6 32	9 56	5 17	11 56	4 25	16 50	3 7		
0 49	25 49	1 58	18 45	3 58	11 56	5 58	8 31	7 58	6 31	9 58	5 16	11 58	4 24	16 55	3 6		
0 50	25 41	2 0	18 35	4 0	11 51	6 0	8 28	8 0	6 29	10 0	5 15	12 0	4 23	17 0	3 5		
0 51	25 34	2 2	18 26	4 2	11 47	6 2	8 26	8 2	6 28	10 2	5 14	12 5	4 22	17 5	3 4		
0 52	25 26	2 4	18 16	4 4	11 42	6 4	8 23	8 4	6 26	10 4	5 13	12 10	4 20	17 10	3 3		
0 53	25 19	2 6	18 7	4 6	11 38	6 6	8 20	8 6	6 25	10 6	5 12	12 15	4 18	17 15	3 2		
0 54	25 11	2 8	17 57	4 8	11 33	6 8	8 18	8 8	6 23	10 8	5 11	12 20	4 16	17 20	3 1		
0 55	25 4	2 10	17 48	4 10	11 29	6 10	8 15	8 10	6 22	10 10	5 10	12 25	4 15	17 25	3 0		
0 56	24 57	2 12	17 39	4 12	11 25	6 12	8 13	8 12	6 21	10 12	5 9	12 30	4 13	17 30	2 59		
0 57	24 50	2 14	17 30	4 14	11 21	6 14	8 10	8 14	6 19	10 14	5 8	12 35	4 11	17 35	2 58		
0 58	24 42	2 16	17 22	4 16	11 16	6 16	8 8	8 16	6 18	10 16	5 7	12 40	4 9	17 40	2 57		
0 59	24 35	2 18	17 13	4 18	11 12	6 18	8 5	8 18	6 16	10 18	5 6	12 45	4 8	17 45	2 56		

TABLE IV.

Mean Refraction.

For Height of the Barometer 29.6 Inches, and Thermometer 50°.

Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.	Alt.	Ref.
° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	°	′ ″
17 50	2 55	19 55	2 37	23 0	2 14	27 10	1 51	31 20	1 34	38 0	1 13	48 0	0 51	66	0 25
17 55	2 55	20 0	2 35	23 10	2 13	27 20	1 50	31 30	1 33	38 20	1 12	48 30	0 50	67	0 24
18 0	2 54	20 5	2 35	23 20	2 12	27 30	1 49	31 40	1 32	38 40	1 11	49 0	0 49	68	0 23
18 5	2 53	20 10	2 34	23 30	2 11	27 40	1 49	31 50	1 32	39 0	1 10	49 30	0 49	69	0 22
18 10	2 52	20 15	2 33	23 40	2 10	27 50	1 48	32 0	1 31	39 20	1 9	50 0	0 48	70	0 21
18 15	2 52	20 20	2 32	23 50	2 9	28 0	1 47	32 10	1 31	39 40	1 9	50 30	0 47	71	0 19
18 20	2 51	20 25	2 32	24 0	2 8	28 10	1 46	32 20	1 30	40 0	1 8	51 0	0 46	72	0 18
18 25	2 50	20 30	2 31	24 10	2 7	28 20	1 45	32 30	1 30	40 20	1 7	51 30	0 45	73	0 17
18 30	2 49	20 35	2 30	24 20	2 6	28 30	1 45	32 40	1 29	40 40	1 6	52 0	0 44	74	0 16
18 35	2 48	20 40	2 29	24 30	2 5	28 40	1 44	32 50	1 29	41 0	1 5	52 30	0 44	75	0 15
18 40	2 47	20 45	2 29	24 40	2 4	28 50	1 43	33 0	1 28	41 20	1 4	53 0	0 43	76	0 14
18 45	2 47	20 50	2 28	24 50	2 3	29 0	1 42	33 20	1 27	41 40	1 4	53 30	0 42	77	0 13
18 50	2 46	20 55	2 28	25 0	2 2	29 10	1 42	33 40	1 25	42 0	1 3	54 0	0 41	78	0 12
18 55	2 45	21 0	2 27	25 10	2 1	29 20	1 41	34 0	1 24	42 20	1 2	54 30	0 41	79	0 11
19 0	2 44	21 10	2 26	25 20	2 0	29 30	1 40	34 20	1 23	42 40	1 2	55 0	0 40	80	0 10
19 5	2 44	21 20	2 25	25 30	1 59	29 40	1 39	34 40	1 22	43 0	1 1	56 0	0 38	81	0 9
19 10	2 43	21 30	2 24	25 40	1 58	29 50	1 38	35 0	1 21	43 30	1 0	57 0	0 37	82	0 8
19 15	2 42	21 40	2 23	25 50	1 57	30 0	1 38	35 20	1 20	44 0	0 59	58 0	0 35	83	0 7
19 20	2 41	21 50	2 21	26 0	1 56	30 10	1 38	35 40	1 19	44 30	0 58	59 0	0 34	84	0 6
19 25	2 41	22 0	2 20	26 10	1 55	30 20	1 37	36 0	1 18	45 0	0 57	60 0	0 33	85	0 5
19 30	2 40	22 10	2 19	26 20	1 55	30 30	1 37	36 20	1 17	45 30	0 56	61 0	0 32	86	0 4
19 35	2 39	22 20	2 18	26 30	1 54	30 40	1 36	36 40	1 17	46 0	0 55	62 0	0 30	87	0 3
19 40	2 38	22 30	2 17	26 40	1 53	30 50	1 36	37 0	1 16	46 30	0 54	63 0	0 29	88	0 2
19 45	2 38	22 40	2 16	26 50	1 52	31 0	1 35	37 20	1 15	47 0	0 53	64 0	0 28	89	0 1
19 50	2 37	22 50	2 15	27 0	1 51	31 10	1 34	37 40	1 14	47 30	0 52	65 0	0 26	90	0 0

TABLE IV.*

Correction of the Mean Refraction.

For Heights of the Barometer and Thermometer.

Therm.	Mean Refraction.																	Barom.
	10″	20″	30″	40″	50″	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	20′	30′	
°	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	+ ″	
0	1	3	4	6	7	9	17	26	34	43	51	60	69	77	86	171	257	
4	1	3	4	6	7	8	16	23	31	39	47	55	62	70	78	156	234	
8	1	2	4	5	6	7	14	21	28	35	42	49	56	63	70	141	211	
12	1	2	3	4	5	6	13	19	25	32	38	44	50	57	63	126	189	
16	1	2	3	4	5	6	11	17	22	28	33	39	45	50	56	111	167	
20	1	2	2	3	4	5	10	15	19	24	29	34	39	44	49	97	146	
24	1	1	2	3	4	4	8	13	17	21	25	29	33	38	42	83	125	
28	1	1	2	2	3	3	7	10	14	17	21	24	28	31	35	70	105	31.3
32	0	1	1	2	2	3	6	8	11	14	17	20	23	25	28	57	85	31.0
36	0	1	1	1	2	2	4	7	9	11	13	15	17	20	21	44	65	30.7
40	0	1	1	1	1	2	3	5	6	8	9	11	12	14	15	31	46	30.4
44	0	0	0	1	1	1	2	3	4	5	5	6	7	8	9	18	27	30.1
48	0	0	0	0	0	0	0	1	1	2	2	2	2	3	3	6	9	29.8
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
52	0	0	0	0	0	0	0	1	1	2	2	2	2	3	3	6	9	29.5
56	0	0	0	1	1	1	2	3	4	4	5	6	7	8	9	18	27	29.2
60	0	0	1	1	1	1	3	5	6	7	9	10	12	13	15	29	44	28.9
64	0	1	1	1	2	2	4	6	8	10	12	14	16	18	20	41	60	28.6
68	0	1	1	2	2	3	5	8	10	13	15	18	21	23	26	52	77	28.3
72	1	1	2	2	3	3	6	9	13	16	19	22	25	28	31	63	94	28.1
76	1	1	2	2	3	4	7	11	15	18	22	26	29	33	37	73	110	
80	1	1	2	3	3	4	8	13	17	21	25	29	34	38	42	84	126	
84	1	2	2	3	4	5	9	14	19	24	28	33	38	42	47	94	141	
88	1	2	3	3	4	5	10	16	21	26	31	36	42	47	52	104	156	
92	1	2	3	4	5	6	11	17	23	29	34	40	46	51	57	114	171	
96	1	2	3	4	5	6	12	19	25	31	37	43	50	56	62	124	186	
100	1	2	3	4	6	7	13	20	27	33	40	47	53	60	67	133	200	

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude. 7°												8°											
	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′
° ′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
7 0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 0	2	1	1	1	1	1	1	0	0	0	0	0	0	...	...	...	...	...	...	...	...	...	...	...
9 0	4	3	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	0	0	0	0	0
10 0	7	6	6	6	5	5	5	4	4	4	3	3	3	2	2	2	2	2	1	1	1	1	1	0
11 0	10	10	10	9	9	8	8	7	7	7	6	6	6	5	5	4	4	4	4	4	3	3	3	2
12 0	15	14	14	13	13	12	12	11	11	10	10	9	9	8	8	7	7	7	6	6	6	5	5	4
13 0	20	19	19	18	18	17	16	16	15	14	14	13	13	12	12	11	11	10	10	9	9	8	8	8
14 0	25	24	24	23	23	22	21	21	20	19	18	17	17	16	16	15	15	14	14	13	12	12	11	11
15 0	31	30	29	28	28	27	26	26	25	24	23	22	21	21	20	19	19	18	18	17	16	16	15	14
16 0	37	36	34	34	33	32	31	30	30	29	28	27	26	25	25	24	23	22	22	21	20	20	19	18
17 0	43	42	40	39	38	37	36	35	35	34	33	32	31	30	30	28	28	27	26	25	25	24	23	22
18 0	49	48	47	45	44	43	42	41	40	39	38	37	36	35	34	33	32	32	31	30	29	28	27	26
19 0	55	54	53	51	50	49	48	46	45	44	43	42	41	40	39	38	37	36	35	35	34	33	32	31
20 0	61	60	59	57	56	55	54	52	51	50	49	48	46	45	44	43	42	41	40	39	38	37	36	35
20 30	64	63	62	60	59	58	57	55	54	53	52	51	49	48	47	46	45	44	43	42	41	40	39	38
21 0	67	66	65	63	62	61	59	58	57	56	54	53	52	51	50	48	47	46	45	44	43	42	41	40
21 30	71	69	68	66	65	64	62	61	60	59	57	56	54	53	52	51	50	49	48	47	46	44	43	42
22 0	74	72	71	70	68	67	65	64	63	62	60	58	57	56	55	54	53	52	50	49	48	47	46	45
22 30	77	76	74	73	71	70	68	67	66	64	63	61	60	59	58	56	55	54	53	52	51	49	48	47
23 0	80	79	77	76	74	73	71	70	69	67	66	64	63	61	60	59	58	57	55	54	53	52	51	49
23 30	83	82	80	79	77	76	74	73	71	70	69	67	65	64	63	62	60	59	58	57	56	54	53	52
24 0	87	85	84	82	80	79	77	76	74	73	71	70	68	67	66	64	63	62	61	59	58	57	56	54
24 30	90	88	87	85	83	82	80	79	77	76	74	72	71	69	68	67	66	64	63	62	61	59	58	57
25 0	93	91	90	88	87	85	83	82	80	78	77	75	74	72	71	70	68	67	66	64	63	62	60	59
25 30	96	95	93	91	90	88	86	85	83	81	79	78	76	75	74	72	71	70	68	67	66	64	63	61
26 0	99	98	96	94	93	91	89	88	86	84	82	81	79	78	76	75	74	72	71	69	68	67	65	64
26 30	103	101	99	97	96	94	92	90	89	87	85	84	82	80	79	78	76	75	73	72	70	69	68	66
27 0	106	104	102	100	99	97	95	93	92	90	88	87	85	83	82	80	79	77	76	74	73	72	70	69
27 30	109	107	105	103	102	100	98	96	94	93	91	90	87	86	84	83	81	80	78	77	76	74	73	71
28 0	112	110	108	106	105	103	101	99	97	95	94	92	90	89	87	86	84	83	81	80	78	77	75	74
28 30	115	113	112	110	108	106	104	102	100	98	97	95	93	91	90	88	87	85	84	82	81	79	77	76
29 0	118	117	115	113	111	109	107	105	103	101	100	98	96	94	93	91	89	88	86	85	83	82	80	78
29 30	122	120	118	116	114	112	110	108	106	104	102	100	98	97	95	94	92	90	89	87	86	84	82	81
30 0	125	123	121	119	117	115	113	111	109	107	105	103	101	100	98	96	95	93	91	90	88	87	85	83
30 30	128	126	124	122	120	118	116	114	112	110	108	106	104	102	101	99	97	96	94	92	91	90	87	86
31 0	131	129	127	125	123	121	119	117	115	113	111	109	107	105	103	102	100	98	97	95	93	92	90	88
31 30	134	132	130	128	126	124	122	120	118	116	113	111	109	108	106	104	103	101	99	97	96	94	92	90
32 0	137	135	133	131	129	127	125	123	121	118	116	114	112	110	109	107	105	103	102	100	98	96	95	93
32 30	140	138	136	134	132	130	128	126	124	121	119	117	115	113	111	110	108	105	104	102	101	99	97	95
33 0	143	141	139	137	135	133	131	128	126	124	122	120	118	116	114	112	110	109	107	105	103	101	100	98
33 30	146	144	142	140	138	136	133	131	129	127	125	122	120	118	117	115	113	111	109	107	106	104	102	100
34 0	150	147	145	143	141	138	136	134	132	130	127	125	123	121	119	117	116	114	112	110	108	106	104	103
34 30	153	150	148	146	143	141	139	137	134	132	130	128	125	124	122	120	118	116	114	112	110	109	107	105
35 0	156	153	151	149	146	144	142	139	137	135	133	130	128	126	124	122	120	118	117	115	113	111	109	107
35 30	159	156	154	152	149	147	145	142	140	138	135	133	131	129	127	125	123	121	119	117	115	113	111	109
36 0	162	159	157	154	152	150	147	145	143	140	138	136	133	131	129	127	125	124	122	120	118	116	114	112
36 30	165	162	160	157	155	153	150	148	145	143	141	138	136	134	132	130	128	126	124	122	120	118	116	114
37 0	168	165	163	160	158	155	153	151	148	146	143	141	139	137	135	132	130	128	126	124	122	120	118	116
37 30	171	168	166	163	161	158	156	153	151	149	146	144	141	139	137	135	133	131	129	127	125	123	121	119
38 0	174	171	169	166	164	161	159	156	154	151	149	146	144	142	140	138	136	134	131	129	127	125	123	121
38 30	177	174	172	169	166	164	161	159	156	154	151	149	146	144	142	140	138	136	134	132	130	128	125	123
39 0	179	177	174	172	169	167	164	162	159	157	154	152	149	147	145	143	141	138	136	134	132	130	128	126
39 30	182	180	177	175	172	169	167	164	162	159	157	154	151	149	147	145	143	141	139	136	134	132	130	128
40 0	185	183	180	177	175	172	170	167	164	162	159	157	154	152	150	147	145	143	141	139	137	134	132	130
40 30	188	185	183	180	177	175	172	170	167	164	162	159	156	154	152	150	148	145	143	141	139	137	135	132
41 0	191	188	186	183	180	178	175	172	170	167	164	162	159	157	155	152	150	148	146	143	141	139	137	135
41 30	194	191	188	186	183	180	177	175	172	169	167	164	161	159	157	155	152	150	148	146	143	141	139	137
42 0	196	194	191	188	186	183	180	177	175	172	169	166	164	161	159	157	155	152	150	148	146	143	141	139
42 30	199	196	194	191	188	185	183	180	177	174	172	169	166	164	162	159	157	155	153	150	148	146	143	141
43 0	202	199	196	194	191	188	185	183	180	177	174	171	169	166	164	162	160	157	155	153	150	148	146	143

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude.																							
	7°												8°											
	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′
° ′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
43 0	202	199	196	194	191	188	185	183	180	177	174	171	169	166	164	162	160	157	155	153	150	148	146	143
43 30	205	202	199	196	193	191	188	185	182	179	177	174	171	169	166	164	162	159	157	155	152	150	148	145
44 0	207	204	202	199	196	193	190	188	185	182	179	176	173	171	169	166	164	162	159	157	155	152	150	148
44 30	210	207	204	201	199	196	193	190	187	184	181	179	176	173	171	169	166	164	162	159	157	154	152	150
45 0	213	210	207	204	201	198	195	192	190	187	184	181	178	176	173	171	169	166	164	161	160	157	154	152
45 30	215	212	209	206	204	201	198	195	192	189	186	183	180	178	176	173	171	168	166	163	161	159	156	154
46 0	218	215	212	209	206	203	200	197	194	191	188	186	183	180	178	175	173	170	168	166	163	161	158	156
46 30	220	217	215	212	209	206	203	200	197	194	191	188	185	182	180	178	175	173	170	168	165	163	160	158
47 0	223	220	217	214	211	208	205	202	199	196	193	190	187	185	182	180	177	175	172	170	167	165	162	160
47 30	226	223	220	216	213	210	207	204	201	198	195	192	189	187	184	182	179	177	174	172	169	167	164	162
48 0	228	225	222	219	216	213	210	207	204	201	198	195	192	189	187	184	182	179	176	174	171	169	166	164
48 30	230	227	224	221	218	215	212	209	206	203	200	197	194	191	189	186	184	181	178	176	173	171	168	166
49 0	233	230	227	224	221	218	214	211	208	205	202	199	196	193	191	188	186	183	181	178	175	173	170	168
49 30	235	232	229	226	223	220	217	214	211	207	204	201	198	195	193	190	188	185	183	180	177	175	172	170
50 0	238	235	232	228	225	222	219	216	213	210	207	203	200	198	195	192	190	187	185	182	179	177	174	172
50 30	240	237	234	231	228	225	221	218	215	212	209	206	202	200	197	194	192	189	187	184	181	179	176	173
51 0	243	240	236	233	230	227	224	220	217	214	211	208	205	202	199	197	194	191	189	186	183	181	178	175
51 30	245	242	239	235	232	229	226	223	219	216	213	210	207	204	201	199	196	193	191	188	185	183	180	177
52 0	248	244	241	238	235	231	228	225	222	218	215	212	209	206	203	201	198	195	193	190	187	185	182	179
52 30	250	247	243	240	237	234	230	227	224	220	217	214	211	208	205	203	200	197	194	192	189	186	184	181
53 0	252	249	246	242	239	236	232	229	226	223	219	216	213	210	207	205	202	199	196	194	191	188	185	183
53 30	254	251	248	244	241	238	235	231	228	225	221	218	215	212	209	206	204	201	198	196	193	190	187	185
54 0	257	253	250	247	243	240	237	233	230	227	223	220	217	214	211	208	206	203	200	197	195	192	189	186
54 30	259	255	252	249	245	242	239	235	232	229	225	222	219	216	213	210	208	205	202	199	196	194	191	188
55 0	261	258	254	251	248	244	241	237	234	231	227	224	221	218	215	212	209	207	204	201	198	195	193	190
55 30	263	260	256	253	250	246	243	239	236	233	229	226	222	220	217	214	211	208	206	203	200	197	194	192
56 0	265	262	259	255	252	248	245	241	238	235	231	228	224	222	219	216	213	210	207	205	202	199	196	193
56 30	267	264	261	257	254	250	247	243	240	236	233	230	226	223	221	218	215	212	209	206	203	201	198	195
57 0	269	266	263	259	256	252	249	245	242	238	235	232	228	225	222	219	217	214	211	208	205	202	199	196
57 30	271	268	265	261	258	254	251	247	244	240	237	233	230	227	224	221	218	215	212	210	207	204	201	198
58 0	273	270	267	263	260	256	253	249	246	242	239	235	232	229	226	223	220	217	214	211	208	206	203	200
58 30	275	272	268	265	261	258	254	251	247	244	240	237	233	230	228	225	222	219	216	213	210	207	204	201
59 0	277	274	270	267	263	260	256	253	249	246	242	239	235	232	229	226	223	220	217	215	212	209	206	203
59 30	279	276	272	269	265	262	258	254	251	247	244	240	237	234	231	228	225	222	219	216	213	210	207	204
60 0	281	278	274	271	267	263	260	256	253	249	246	242	239	236	233	230	227	224	221	218	215	212	209	206
60 30	283	279	276	272	269	265	262	258	254	251	247	244	240	237	234	231	228	225	222	219	216	213	210	207
61 0	285	281	278	274	271	267	263	260	256	253	249	245	242	239	236	233	230	227	224	221	218	215	212	209
61 30	287	283	280	276	272	269	265	261	258	254	251	247	243	240	237	234	231	228	225	222	219	216	213	210
62 0	288	285	281	278	274	270	267	263	260	256	252	249	245	242	239	236	233	230	227	224	221	218	215	212
62 30	290	287	283	279	276	272	268	265	261	257	254	250	247	243	240	237	234	231	228	225	222	219	216	213
63 0	292	288	285	281	277	274	270	266	263	259	255	252	248	245	242	239	236	233	230	227	224	220	217	214
63 30	294	290	286	283	279	275	272	268	264	261	257	253	250	246	243	240	237	234	231	228	225	222	219	216
64 0	296	292	288	284	281	277	273	270	266	262	259	255	251	248	245	242	239	236	233	229	226	223	220	217
64 30	297	293	290	286	282	279	275	271	267	264	260	256	253	249	246	243	240	237	234	231	228	225	221	218
65 0	299	295	292	288	284	280	276	273	269	265	261	258	254	251	248	245	241	238	235	232	229	226	223	220
66 0	302	298	295	291	287	283	279	275	272	268	264	261	257	254	251	247	244	241	238	235	232	229	225	222
67 0	305	301	297	294	290	286	282	278	275	271	267	263	259	256	253	250	247	244	240	237	234	231	228	225
68 0	308	304	300	296	293	289	285	281	277	274	270	266	262	259	256	252	249	246	243	240	237	233	230	227
69 0	311	307	303	299	295	291	288	284	280	276	272	268	265	261	258	255	252	248	245	242	239	236	232	229
70 0	313	310	306	302	298	294	290	286	282	279	275	271	267	264	260	257	254	251	248	244	241	238	235	231
72 0	318	314	311	307	303	299	295	291	287	283	279	275	271	268	265	261	258	255	252	248	245	242	239	235
74 0	323	319	315	311	307	303	299	295	291	287	283	279	275	272	269	265	262	259	255	252	249	245	242	239
76 0	327	323	319	315	311	307	303	299	295	291	287	283	279	275	272	269	265	262	258	255	252	248	245	242
78 0	330	326	322	318	314	310	306	302	298	294	290	286	282	278	275	272	268	265	261	258	255	251	248	245
80 0	333	329	325	321	317	313	309	305	301	297	292	288	284	281	278	274	270	267	264	261	257	254	250	247
82 0	336	331	327	323	319	315	311	307	303	299	295	291	286	283	280	276	272	269	266	263	259	256	252	249
84 0	337	333	329	325	321	317	313	309	304	300	296	292	288	285	281	278	274	271	268	264	261	257	254	250
86 0	339	335	330	326	322	318	314	310	305	301	297	293	289	286	282	279	275	272	269	265	262	258	255	251
88 0	339	335	331	327	323	319	315	310	306	302	298	294	290	286	283	279	276	273	269	266	262	259	255	252
90 0	340	336	331	327	323	319	315	311	307	302	298	294	290	287	283	280	276	273	269	266	263	259	256	252

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude. 9°												10°											
	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′
° ′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
9 0	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
10 0	0	0	0	0	0	0	0	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…	…
11 0	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
12 0	4	4	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	0	0
13 0	7	7	7	6	6	6	5	5	5	5	4	4	4	4	3	3	3	3	3	2	2	2	2	2
14 0	10	10	9	9	9	8	8	8	7	7	7	6	6	6	5	5	5	5	5	4	4	4	4	3
15 0	14	13	13	13	12	12	11	11	10	10	10	9	9	9	8	8	8	7	7	7	6	6	6	5
16 0	17	17	16	16	16	15	15	14	14	13	13	12	12	11	11	11	10	10	10	9	9	9	8	8
17 0	21	21	20	20	19	19	18	18	17	17	16	16	15	14	14	14	13	13	13	12	12	11	11	10
18 0	25	25	24	24	23	23	22	21	21	20	20	19	18	18	17	17	16	16	16	15	15	14	14	13
19 0	30	29	29	28	27	27	26	25	25	24	23	23	22	22	21	21	20	19	19	18	18	17	17	16
20 0	34	34	33	32	31	31	30	29	29	28	27	26	26	25	25	24	23	23	22	22	21	20	20	19
20 30	36	36	35	34	34	33	32	31	31	30	29	28	28	27	27	26	25	25	24	24	23	22	22	21
21 0	39	38	37	37	36	35	34	34	33	32	31	30	30	29	28	28	27	27	26	25	25	24	23	23
21 30	41	40	40	39	38	37	36	36	35	34	33	32	32	31	30	30	29	28	28	27	27	26	25	25
22 0	44	43	42	41	40	40	39	38	37	36	35	35	34	33	32	32	31	30	30	29	28	28	27	26
22 30	46	45	44	43	43	42	41	40	39	38	37	37	36	35	34	34	33	32	32	31	30	30	29	28
23 0	48	47	47	46	45	44	43	42	41	41	40	39	38	37	36	36	35	34	34	33	32	31	31	30
23 30	51	50	49	48	47	46	45	44	43	43	42	41	40	39	38	38	37	36	35	35	34	33	32	32
24 0	53	52	51	50	49	48	48	47	46	45	44	43	42	41	40	40	39	38	37	37	36	35	34	34
24 30	55	54	54	53	52	51	50	49	48	47	46	45	44	43	43	42	41	40	39	39	38	37	36	35
25 0	58	57	56	55	54	53	52	51	50	49	48	47	46	46	45	44	43	42	41	41	40	39	38	37
25 30	60	59	58	57	56	55	54	53	52	51	50	49	48	48	47	46	45	44	43	42	42	41	40	39
26 0	62	62	61	59	58	57	56	55	54	53	52	51	50	50	49	48	47	46	45	44	43	43	42	41
26 30	65	64	63	62	61	60	59	58	57	55	54	53	52	52	51	50	49	48	47	46	45	44	44	43
27 0	67	66	65	64	63	62	61	60	59	58	56	55	54	54	53	52	51	50	49	48	47	46	45	45
27 30	70	68	67	66	65	64	63	62	61	60	59	58	56	56	55	54	53	52	51	50	49	48	47	46
28 0	72	71	70	69	68	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
28 30	74	73	72	71	70	69	68	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50
29 0	77	76	75	73	72	71	70	69	68	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52
29 30	79	78	77	76	75	73	72	71	70	69	67	66	65	64	63	62	61	60	59	58	57	56	55	54
30 0	82	81	79	78	77	76	74	73	72	71	70	69	67	66	65	64	63	62	61	60	59	58	57	56
30 30	84	83	82	80	79	78	77	75	74	73	72	71	69	68	67	66	65	64	63	62	61	60	59	58
31 0	86	85	84	83	82	80	79	78	77	75	74	73	71	70	69	68	67	66	65	64	63	62	61	60
31 30	89	88	86	85	84	83	81	80	79	77	76	75	74	72	71	70	69	68	67	66	65	64	63	62
32 0	91	90	88	87	86	85	84	82	81	80	78	77	76	75	74	72	71	70	69	68	67	66	65	64
32 30	94	92	91	90	88	87	86	84	83	82	81	79	78	77	76	74	73	72	71	70	69	68	67	65
33 0	96	95	93	92	91	89	88	87	85	84	83	81	80	79	78	76	75	74	73	72	71	70	69	67
33 30	98	97	96	94	93	92	90	89	87	86	85	83	82	81	80	78	77	76	75	74	73	72	70	69
34 0	101	99	98	97	95	94	92	91	90	88	87	85	84	83	82	80	79	78	77	76	75	74	72	71
34 30	103	102	100	99	97	96	95	93	92	90	89	88	86	85	84	82	81	80	79	78	77	75	74	73
35 0	105	104	102	101	99	98	97	95	94	92	91	90	88	87	86	84	83	82	81	80	78	77	76	75
35 30	107	106	105	103	102	100	99	97	96	94	93	92	90	89	88	86	85	84	83	82	80	79	78	77
36 0	110	108	107	105	104	103	101	100	98	97	95	94	92	91	90	88	87	86	85	84	82	81	80	78
36 30	112	111	109	108	106	105	103	102	100	99	97	96	94	93	92	90	89	88	87	85	84	83	82	80
37 0	114	113	111	110	108	107	105	104	102	101	99	98	96	95	94	92	91	90	89	87	86	85	83	82
37 30	117	115	114	112	111	109	108	106	105	103	101	100	98	97	96	94	93	92	91	89	88	87	85	84
38 0	119	118	116	114	113	111	110	108	107	105	104	102	101	99	98	96	95	94	93	91	90	89	87	86
38 30	121	120	118	117	115	114	112	110	109	107	106	104	103	101	100	98	97	96	95	93	92	91	89	88
39 0	124	122	120	119	117	116	114	113	111	109	108	106	105	103	102	100	99	98	97	95	94	93	91	90
39 30	126	124	123	121	119	118	116	115	113	111	110	108	107	105	104	102	101	100	98	97	96	94	93	92
40 0	128	126	125	123	122	120	118	117	115	113	112	110	109	107	106	104	103	102	100	99	98	96	95	93
40 30	130	129	127	125	124	122	120	119	117	115	114	112	111	109	108	106	105	104	102	101	99	98	97	95
41 0	132	131	129	127	126	124	122	121	119	117	116	114	113	111	110	108	107	105	104	103	101	100	98	97
41 30	134	133	131	129	128	126	124	123	121	119	118	116	114	113	112	110	109	107	106	104	103	101	100	99
42 0	137	135	133	132	130	128	127	125	123	121	120	118	116	115	114	112	111	109	108	106	105	103	102	100
42 30	139	137	136	134	132	130	129	127	125	123	122	120	118	117	115	114	112	111	109	108	107	105	104	102
43 0	141	139	138	136	134	132	131	129	127	125	124	122	120	119	117	116	114	113	111	110	108	107	105	104
43 30	143	141	140	138	136	134	133	131	129	127	126	124	122	121	119	118	116	115	113	112	110	109	107	106
44 0	145	143	142	140	138	136	135	133	131	129	128	126	124	123	121	120	118	116	115	113	112	110	109	107

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude.											
	9°											
	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′
° ′	″	″	″	″	″	″	″	″	″	″	″	″
44 0	145	143	142	140	138	136	135	133	131	129	128	126
44 30	147	145	144	142	140	138	137	135	133	131	129	128
45 0	149	147	146	144	142	140	139	137	135	133	131	130
45 30	151	149	148	146	144	142	141	139	137	135	133	131
46 0	153	151	150	148	146	144	142	141	139	137	135	133
46 30	155	153	152	150	148	146	144	142	141	139	137	135
47 0	157	155	154	152	150	148	146	144	142	141	139	137
47 30	159	157	156	154	152	150	148	146	144	142	140	139
48 0	161	159	157	156	154	152	150	148	146	144	142	140
48 30	163	161	159	157	155	154	152	150	148	146	144	142
49 0	165	163	161	159	157	155	153	152	150	148	146	144
49 30	167	165	163	161	159	157	155	153	151	149	148	146
50 0	169	167	165	163	161	159	157	155	153	151	149	147
50 30	171	169	167	165	163	161	159	157	155	153	151	149
51 0	173	171	169	167	165	163	161	159	157	155	153	151
51 30	175	173	171	169	166	165	163	161	158	156	154	152
52 0	177	174	172	170	168	166	164	162	160	158	156	154
52 30	178	176	174	172	170	168	166	164	162	160	158	156
53 0	180	178	176	174	172	170	168	166	164	161	159	157
53 30	182	180	178	176	174	171	169	167	165	163	161	159
54 0	184	181	179	177	175	173	171	169	167	165	163	161
54 30	185	183	181	179	177	175	173	171	169	166	164	162
55 0	187	185	183	181	179	177	174	172	170	168	166	164
55 30	189	187	184	182	180	178	176	174	172	170	167	165
56 0	190	188	186	184	182	180	178	175	173	171	169	167
56 30	192	190	188	186	183	181	179	177	175	173	170	168
57 0	194	191	189	187	185	183	181	178	176	174	172	170
57 30	195	193	191	189	186	184	182	180	178	176	173	171
58 0	197	195	192	190	188	186	184	181	179	177	175	173
58 30	198	196	194	192	189	187	185	183	181	178	176	174
59 0	200	198	195	193	191	189	187	184	182	180	178	175
59 30	201	199	197	195	192	190	188	186	184	181	179	177
60 0	203	201	198	196	194	192	189	187	185	183	180	178
60 30	204	202	200	198	195	193	191	189	186	184	182	179
61 0	206	203	201	199	197	194	192	190	188	185	183	181
61 30	207	205	203	200	198	196	193	191	189	187	184	182
62 0	209	206	204	202	199	197	195	193	190	188	186	183
62 30	210	208	205	203	201	198	196	194	192	189	187	185
63 0	211	209	207	204	202	200	197	195	193	190	188	186
63 30	213	210	208	206	203	201	199	196	194	192	189	187
64 0	214	212	209	207	205	202	200	198	195	193	191	188
64 30	215	213	211	208	206	203	201	199	196	194	192	189
65 0	217	214	212	209	207	205	202	200	198	195	193	191
66 0	219	217	214	212	210	207	205	202	200	198	195	193
67 0	221	219	217	214	212	209	207	205	202	200	197	195
68 0	224	221	219	216	214	212	209	207	204	202	200	197
69 0	226	223	221	219	216	214	211	209	206	204	202	199
70 0	228	225	223	221	218	216	213	211	208	206	204	201
71 0	230	227	225	223	220	218	215	213	210	208	205	203
72 0	232	229	227	225	222	220	217	215	212	210	207	205
73 0	234	231	229	226	224	221	219	216	214	211	209	206
74 0	235	233	231	228	225	223	220	218	215	213	210	208
76 0	238	236	234	231	228	226	223	221	218	216	213	211
78 0	241	239	236	234	231	228	226	223	221	218	216	213
80 0	244	241	238	236	233	231	228	225	223	220	218	215
82 0	246	243	240	238	235	233	230	227	225	222	220	217
84 0	247	244	242	239	236	234	231	229	226	223	221	218
86 0	248	245	243	240	237	235	232	230	227	224	222	219
88 0	248	246	243	241	238	235	233	230	228	225	222	220
90 0	249	246	244	241	238	236	233	231	228	225	223	220

Greater App. Alt.	The Less Apparent Altitude.											
	10°											
	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′
	″	″	″	″	″	″	″	″	″	″	″	″
	124	123	121	120	118	116	115	113	112	110	109	107
	126	124	123	121	120	118	117	115	114	112	110	109
	128	126	125	123	122	120	118	117	115	114	112	111
	130	128	126	125	123	122	120	119	117	115	114	112
	131	130	128	127	125	123	122	120	119	117	115	114
	133	131	130	128	127	125	124	122	120	119	117	116
	135	133	132	130	129	127	125	124	122	121	119	117
	137	135	134	132	130	129	127	125	124	122	121	119
	139	137	135	134	132	130	129	127	125	124	122	121
	140	139	137	135	134	132	130	129	127	125	124	122
	142	140	139	137	135	134	132	130	129	127	125	124
	144	142	140	139	137	135	133	132	130	128	127	125
	145	144	142	140	139	137	135	133	132	130	128	127
	147	145	144	142	140	138	137	135	133	132	130	128
	149	147	145	144	142	140	138	137	135	133	131	130
	150	149	147	145	143	142	140	138	136	135	133	131
	152	150	149	147	145	143	142	140	138	136	135	133
	154	152	150	148	147	145	143	141	140	138	136	134
	155	153	152	150	148	146	145	143	141	139	137	136
	157	155	153	152	150	148	146	144	143	141	139	137
	159	157	155	153	151	149	148	146	144	142	140	139
	160	158	157	155	153	151	149	147	146	144	142	140
	162	160	158	156	154	153	151	149	147	145	143	142
	163	161	160	158	156	154	152	150	148	147	145	143
	165	163	161	159	157	155	154	152	150	148	146	144
	166	164	162	161	159	157	155	153	151	149	148	146
	168	166	164	162	160	158	156	154	153	151	149	147
	169	167	165	163	161	160	158	156	154	152	150	148
	170	169	167	165	163	161	159	157	155	153	151	150
	172	170	168	166	164	162	160	158	156	155	153	151
	173	171	169	167	166	164	162	160	158	156	154	152
	175	173	171	169	167	165	163	161	159	157	155	153
	176	174	172	170	168	166	164	162	160	159	157	155
	177	175	173	171	169	167	166	164	162	160	158	156
	179	177	175	173	171	169	167	165	163	161	159	157
	180	178	176	174	172	170	168	166	164	162	160	158
	181	179	177	175	173	171	169	167	165	163	161	159
	182	180	178	176	174	172	170	168	166	164	162	160
	184	182	180	177	175	173	171	169	167	165	163	161
	185	183	181	179	177	175	173	171	169	167	165	163
	186	184	182	180	178	176	174	172	170	168	166	164
	187	185	183	181	179	177	175	173	171	169	167	165
	188	186	184	182	180	178	176	174	172	170	168	166
	191	189	187	184	182	180	178	176	174	172	170	168
	193	191	189	186	184	182	180	178	176	174	172	170
	195	193	191	188	186	184	182	180	178	176	174	171
	197	195	193	190	188	186	184	182	180	178	176	173
	199	197	194	192	190	188	186	184	182	180	177	175
	200	198	196	194	192	190	188	185	183	181	179	177
	202	200	198	196	194	191	189	187	185	183	181	178
	204	201	199	197	195	193	191	189	186	184	182	180
	205	203	201	199	197	194	192	190	188	186	184	181
	208	206	204	202	199	197	195	193	191	189	186	184
	210	208	206	204	202	199	197	195	193	191	188	186
	212	210	208	206	204	201	199	197	195	193	190	188
	214	212	210	208	205	203	201	199	197	195	192	190
	216	213	211	209	207	204	202	200	198	196	193	191
	217	214	212	210	208	205	203	201	198	196	194	192
	217	215	213	210	208	206	204	201	199	197	194	192
	217	215	213	211	208	206	204	201	199	197	195	192

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt	The Less Apparent Altitude. 11°												12°											
	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′
° ′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
11 0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12 0	0	0	0	0	0		0	0	0	0	0	0	0	...	...	...	...	...	...	...	...	...	...	...
13 0	2	1	1		1		1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 0	3	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0
15 0	5	5	5	5	4	4	4	4	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1
16 0	7	7	7	7	6	6	6	6	5	5	5	5	4	4	4	4	4	3	3	3	3	2	2	2
17 0	10	10	9	9	8	8	8	8	8	7	7	7	6	6	6	6	6	5	5	5	5	4	4	4
18 0	13	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	8	7	7	7	7	6	6	6
19 0	16	15	15	15	14	14	13	13	13	12	12	11	11	11	11	10	10	10	9	9	8	8	8	8
20 0	19	18	18	18	17	17	16	16	15	15	15	14	14	13	1	13	12	12	12	11	11	11	10	10
20 30	21	20	20	19	19	18	18	17	17	16	16	15	15	15	14	14	14	13	13	13	12	12	11	11
21 0	22	22	21	21	20	20	19	19	18	18	17	17	16	16	16	15	15	14	14	14	13	13	13	12
21 30	24	23	23	22	22	21	21	20	20	19	19	18	18	18	17	17	17	16	16	15	15	15	14	14
22 0	26	25	25	24	24	23	23	22	22	21	21	20	20	19	19	18	18	17	17	17	16	16	15	15
22 30	28	27	26	26	25	25	24	24	23	23	22	22	21	21	20	20	19	19	18	18	18	17	17	16
23 0	29	29	28	28	27	26	26	25	25	24	24	23	23	22	22	21	21	20	20	19	19	18	18	18
23 30	31	30	30	29	29	28	27	27	26	26	25	25	24	24	23	23	22	22	21	21	20	20	19	19
24 0	33	32	32	31	30	30	29	29	28	27	27	26	26	25	25	24	24	23	23	22	22	21	21	20
24 30	35	34	33	33	32	32	31	30	29	29	28	28	27	27	26	26	25	25	24	24	23	23	22	22
25 0	37	36	35	35	34	33	33	32	31	31	30	30	29	28	28	27	27	26	26	25	25	24	24	23
25 30	38	38	37	36	36	35	34	34	33	32	32	31	30	30	29	29	28	28	27	27	26	26	25	24
26 0	40	39	39	38	37	37	36	35	35	34	33	33	32	31	31	30	30	29	29	28	28	27	26	26
26 30	42	41	40	40	39	38	38	37	36	36	35	34	34	33	32	32	31	31	30	29	29	28	28	27
27 0	44	43	42	42	41	40	39	39	38	37	37	36	35	34	34	33	33	32	32	31	30	30	29	29
27 30	46	45	44	43	43	42	41	40	40	39	38	37	37	36	36	35	34	34	33	33	32	31	31	30
28 0	47	47	46	45	44	44	43	42	41	41	40	39	38	38	37	37	36	35	35	34	33	33	32	32
28 30	49	49	48	47	46	45	45	44	43	42	42	41	40	39	39	38	38	37	36	36	35	34	34	33
29 0	51	50	50	49	48	47	47	46	45	44	43	43	42	41	41	40	39	39	38	37	37	36	35	35
29 30	53	52	52	51	50	49	48	48	47	46	45	44	44	43	42	42	41	40	40	39	38	38	37	36
30 0	55	54	53	53	52	51	50	49	48	48	47	46	45	44	44	43	42	42	41	40	40	39	38	38
30 30	57	56	55	54	54	53	52	51	50	49	49	48	47	46	46	45	44	43	43	42	41	41	40	39
31 0	59	58	57	56	55	55	54	53	52	51	50	49	49	48	47	46	46	45	44	44	43	42	41	41
31 30	61	60	59	58	57	56	55	55	54	53	52	51	50	49	49	48	47	47	46	45	44	44	43	42
32 0	63	62	61	60	59	58	57	56	55	55	54	53	52	51	50	50	49	48	47	47	46	45	45	44
32 30	64	63	63	62	61	60	59	58	57	56	55	54	54	53	52	51	51	50	49	48	48	47	46	45
33 0	66	65	64	63	63	62	61	60	59	58	57	56	55	55	54	53	52	51	51	50	49	48	48	47
33 30	68	67	66	65	64	63	62	62	61	60	59	58	57	56	55	55	54	53	52	51	51	50	49	48
34 0	70	69	68	67	66	65	64	63	62	61	61	60	59	58	57	56	55	55	54	53	52	51	51	50
34 30	72	71	70	69	68	67	66	65	64	63	62	61	60	59	59	58	57	56	55	55	54	53	52	51
35 0	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	59	58	57	56	55	54	54	53
35 30	75	74	73	72	71	70	69	68	67	66	65	64	64	63	62	61	60	59	58	58	57	56	55	54
36 0	77	76	75	74	73	72	71	70	69	68	67	66	65	64	64	63	62	61	60	59	58	58	57	56
36 30	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	63	62	61	60	59	58	57
37 0	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	62	61	60	59
37 30	83	82	81	80	79	78	77	75	74	73	72	71	70	69	68	68	67	66	65	64	63	62	61	60
38 0	85	84	83	82	81	79	78	77	76	75	74	73	72	71	70	69	68	68	67	66	65	64	63	62
38 30	87	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	65	64
39 0	89	87	86	85	84	83	82	81	80	79	78	76	75	74	73	73	72	71	70	69	68	67	66	65
39 30	90	89	88	87	86	85	84	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	67
40 0	92	91	90	89	88	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68
40 30	94	93	91	90	89	88	87	86	85	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69
41 0	96	94	93	92	91	90	89	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71
41 30	97	96	95	94	93	91	90	89	88	87	86	84	83	82	81	80	79	78	77	76	75	74	73	72
42 0	99	98	97	95	94	93	92	91	90	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74
42 30	101	99	98	97	96	95	93	92	91	90	89	88	86	85	84	83	82	81	80	79	78	77	76	75
43 0	102	101	100	99	98	96	95	94	93	92	90	89	88	87	86	85	84	83	82	81	80	79	78	77
43 30	104	103	102	100	99	98	97	96	94	93	92	91	90	88	87	86	85	84	83	82	81	80	79	78
44 0	106	104	103	102	101	100	98	97	96	95	93	92	91	90	89	88	87	86	85	84	83	82	81	79
44 30	107	106	105	104	102	101	100	98	97	96	95	94	93	91	90	89	88	87	86	85	84	83	82	81
45 0	109	108	107	105	104	103	102	100	99	98	97	95	94	93	92	91	90	89	88	87	85	84	83	82

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude.																							
	11°												12°											
	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′
° ′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
45 0	109	108	107	105	104	103	102	100	99	98	97	95	94	93	92	91	90	89	88	87	85	84	83	82
45 30	111	109	108	107	106	104	103	102	101	99	98	97	95	94	93	92	91	90	89	88	87	86	85	84
46 0	112	111	110	108	107	106	105	103	102	101	99	98	97	96	95	94	93	91	90	89	88	87	86	85
46 30	114	113	111	110	109	108	106	105	104	102	101	100	98	97	96	95	94	93	92	91	90	88	87	86
47 0	116	114	113	112	110	109	108	107	105	104	103	101	100	99	98	97	95	94	93	92	91	90	89	88
47 30	117	116	115	113	112	111	109	108	107	105	104	103	101	100	99	98	97	96	95	93	92	91	90	89
48 0	119	118	116	115	114	112	111	110	108	107	106	104	103	102	101	99	98	97	96	95	94	93	91	90
48 30	120	119	118	116	115	114	112	111	110	108	107	106	104	103	102	101	100	98	97	96	95	94	93	92
49 0	122	121	119	118	116	115	114	112	111	110	108	107	106	104	103	102	101	100	99	98	96	95	94	93
49 30	123	122	121	119	118	117	115	114	112	111	110	108	107	106	105	103	102	101	100	99	98	96	95	94
50 0	125	124	122	121	120	118	117	115	114	113	111	110	109	107	106	105	104	103	101	100	99	98	97	95
50 30	126	125	124	122	121	120	118	117	115	114	113	111	110	109	108	106	105	104	103	102	100	99	98	97
51 0	128	127	125	124	122	121	120	118	117	115	114	113	111	110	109	108	106	105	104	103	102	100	99	98
51 30	130	128	127	125	124	122	121	120	118	117	115	114	113	111	110	109	108	107	105	104	103	102	100	99
52 0	131	130	128	127	125	124	123	121	120	118	117	115	114	113	112	110	109	108	107	105	104	103	102	101
52 30	132	131	130	128	127	125	124	122	121	120	118	117	115	114	113	112	110	109	108	107	105	104	103	102
53 0	134	132	131	130	128	127	125	124	122	121	119	118	117	115	114	113	112	110	109	108	107	105	104	103
53 30	135	134	132	131	130	128	127	125	124	122	121	119	118	117	115	114	113	112	110	109	108	107	105	104
54 0	137	135	134	132	131	129	128	127	125	124	122	121	119	118	117	115	114	113	112	110	109	108	107	105
54 30	138	137	135	134	132	131	129	128	127	125	124	122	121	119	118	117	116	114	113	112	110	109	108	107
55 0	140	138	137	135	134	132	131	129	128	126	125	123	122	121	119	118	117	116	114	113	112	110	109	108
55 30	141	140	138	137	135	134	132	131	129	128	126	125	123	122	121	119	118	117	115	114	113	112	110	109
56 0	143	141	140	138	136	135	133	132	130	129	127	126	124	123	122	120	119	118	117	115	114	113	111	110
56 30	144	142	141	139	138	136	135	133	132	130	129	127	126	124	123	122	120	119	118	116	115	114	113	111
57 0	145	144	142	140	139	137	136	134	133	131	130	128	127	125	124	123	121	120	119	118	116	115	114	112
57 30	146	145	143	142	140	139	137	136	134	132	131	129	128	127	125	124	123	121	120	119	117	116	115	113
58 0	148	146	145	143	141	140	138	137	135	134	132	131	129	128	126	125	124	122	121	120	118	117	116	115
58 30	149	147	146	144	143	141	139	138	136	135	133	132	130	129	127	126	125	123	122	121	120	118	117	116
59 0	150	149	147	145	144	142	141	139	138	136	134	133	131	130	129	127	126	125	123	122	121	119	118	117
59 30	151	150	148	147	145	144	142	140	139	137	136	134	133	131	130	128	127	126	124	123	122	120	119	118
60 0	153	151	150	148	146	145	143	142	140	138	137	135	134	132	131	130	128	127	125	124	123	121	120	119
60 30	154	152	151	149	147	146	144	143	141	139	138	136	135	133	132	131	129	128	126	125	124	122	121	120
61 0	155	153	152	150	149	147	145	144	142	141	139	137	136	134	133	132	130	129	127	126	125	123	122	121
61 30	156	154	153	151	150	148	146	145	143	142	140	138	137	135	134	133	131	130	128	127	126	124	123	122
62 0	157	156	154	152	151	149	148	146	144	143	141	139	138	136	135	134	132	131	129	128	127	125	124	123
62 30	158	157	155	153	152	150	149	147	145	144	142	140	139	137	136	135	133	132	130	129	128	126	125	123
63 0	159	158	156	154	153	151	150	148	146	145	143	141	140	138	137	136	134	133	131	130	129	127	126	124
63 30	161	159	157	156	154	152	151	149	147	146	144	142	141	139	138	137	135	134	132	131	130	128	127	125
64 0	162	160	158	157	155	153	152	150	148	147	145	143	142	140	139	138	136	135	133	132	131	129	128	126
64 30	163	161	159	158	156	154	153	151	149	148	146	144	143	141	140	139	137	136	134	133	131	130	129	127
65 0	164	162	160	159	157	155	154	152	150	149	147	145	144	142	141	140	138	137	135	134	132	131	130	128
66 0	166	164	162	161	159	157	156	154	152	151	149	147	146	144	143	141	140	138	137	136	134	133	131	130
67 0	168	166	164	163	161	159	157	156	154	152	151	149	147	146	144	143	142	140	139	137	136	134	133	131
68 0	170	168	166	164	163	161	159	158	156	154	153	151	149	148	146	145	143	142	140	139	138	136	135	133
69 0	171	170	168	166	164	163	161	159	158	156	154	153	151	149	148	146	145	143	142	140	139	138	136	135
70 0	173	171	170	168	166	165	163	161	159	158	156	154	153	151	150	148	147	145	144	142	141	139	138	136
71 0	175	173	171	169	168	166	164	163	161	159	157	156	154	152	151	149	148	146	145	143	142	140	139	137
72 0	176	175	173	171	169	168	166	164	162	161	159	157	155	154	152	151	149	148	146	145	143	142	140	139
73 0	178	176	174	172	171	169	167	165	164	162	160	158	157	155	154	152	151	149	148	146	144	143	141	140
74 0	179	177	176	174	172	170	169	167	165	163	161	160	158	156	155	153	152	150	149	147	146	144	143	141
75 0	181	179	177	175	173	172	170	168	166	164	163	161	159	158	156	154	153	151	150	148	147	145	144	142
76 0	182	180	178	176	175	173	171	169	167	166	164	162	160	159	157	156	154	152	151	149	148	146	145	143
77 0	183	181	179	177	176	174	172	170	168	167	165	163	161	160	158	157	155	153	152	150	149	147	146	144
78 0	184	182	180	178	177	175	173	171	169	168	166	164	162	161	159	158	156	154	153	151	150	148	147	145
80 0	186	184	182	180	179	177	175	173	171	169	168	166	164	162	161	159	158	156	155	153	151	150	148	147
82 0	188	186	184	182	180	178	176	175	173	171	169	167	166	164	162	161	159	158	156	154	153	151	149	148
84 0	189	187	185	183	181	179	177	176	174	172	170	168	166	165	163	162	160	158	157	155	154	152	150	149
86 0	189	188	186	184	182	180	178	176	175	173	171	169	167	166	164	162	161	159	158	156	154	153	151	150
88 0	190	188	186	184	183	181	179	177	175	173	171	170	168	166	165	163	161	160	158	157	155	153	152	150
90 0	190	188	186	185	183	181	179	177	175	173	172	170	168	166	165	163	162	160	158	157	155	154	152	150

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt	The Less Apparent Altitude. 13°												14°											
	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′
° ′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
13 0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14 0	0	0	0	0	0	0	0	0	0	0	0	0	0	...	...	...	...	...	...	...	...	...	...	...
15 0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
16 0	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
17 0	4	4	4	3	3	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
18 0	5	5	5	5	5	4	4	4	4	4	3	3	3	3	3	3	3	2	2	2	2	2	2	2
19 0	7	7	7	7	6	6	6	6	5	5	5	5	5	4	4	4	4	4	3	3	3	3	3	3
20 0	9	9	9	9	8	8	8	8	7	7	7	6	6	6	6	6	5	5	5	5	5	4	4	4
21 0	12	11	11	11	10	10	10	10	9	9	9	8	8	8	8	7	7	7	7	6	6	6	6	6
22 0	15	14	14	13	13	13	12	12	12	11	11	11	10	10	10	9	9	9	9	8	8	8	8	7
22 30	16	15	15	15	14	14	14	13	13	13	12	12	12	11	11	11	10	10	10	10	9	9	9	8
23 0	17	17	16	16	16	15	15	15	14	14	13	13	13	12	12	12	12	11	11	11	10	10	10	9
23 30	18	18	18	17	17	16	16	16	15	15	15	14	14	14	13	13	13	12	12	12	11	11	11	10
24 0	20	19	19	19	18	18	17	17	17	16	16	15	15	15	14	14	14	13	13	13	12	12	12	12
24 30	21	21	20	20	19	19	19	18	18	17	17	17	16	16	16	15	15	15	14	14	14	13	13	13
25 0	23	22	22	21	21	20	20	20	19	19	18	18	17	17	17	16	16	16	15	15	15	14	14	14
25 30	24	23	23	23	22	22	21	21	20	20	19	19	19	18	18	18	17	17	16	16	16	15	15	15
26 0	25	25	24	24	23	23	23	22	22	21	21	20	20	19	19	19	18	18	18	17	17	16	16	16
26 30	27	26	26	25	25	24	24	23	23	22	22	21	21	21	20	20	19	19	19	18	18	18	17	17
27 0	28	27	27	27	26	26	25	25	24	24	23	23	22	22	21	21	21	20	20	19	19	19	18	18
27 30	30	29	29	28	28	27	27	26	26	25	25	24	24	23	23	22	22	21	21	21	20	20	19	19
28 0	31	31	30	29	29	28	28	27	27	26	26	25	25	24	24	24	23	23	22	22	21	21	21	20
28 30	33	32	31	31	30	30	29	29	28	28	27	27	26	26	25	25	24	24	24	23	23	22	22	21
29 0	34	34	33	32	32	31	31	30	30	29	29	28	28	27	27	26	26	25	25	24	24	24	23	23
29 30	36	35	34	34	33	33	32	32	31	30	30	29	29	28	28	27	27	27	26	26	25	25	24	24
30 0	37	36	36	35	35	34	34	33	32	32	31	31	30	30	29	29	28	28	27	27	26	26	25	25
30 30	39	38	37	37	36	36	35	34	34	33	33	32	32	31	31	30	30	29	29	28	28	27	27	26
31 0	40	39	39	38	38	37	36	36	35	35	34	34	33	32	32	32	31	31	30	30	29	29	28	28
31 30	42	41	40	40	39	39	38	37	37	36	36	35	34	34	33	33	32	32	31	31	30	30	29	29
32 0	43	43	42	41	41	40	39	39	38	38	37	36	36	35	35	34	34	33	33	32	32	31	31	30
32 30	45	44	43	43	42	41	41	40	40	39	38	38	37	36	36	35	35	34	34	33	33	32	32	31
33 0	46	45	45	44	44	43	42	42	41	40	40	39	38	38	37	37	36	36	35	35	34	34	33	32
33 30	48	47	46	46	45	44	44	43	42	42	41	40	40	39	39	38	37	37	36	36	35	35	34	34
34 0	49	48	48	47	46	46	45	44	44	43	42	42	41	40	40	39	39	38	38	37	36	36	35	35
34 30	50	50	49	48	48	47	46	46	45	44	44	43	42	42	41	41	40	39	39	38	38	37	37	36
35 0	52	51	51	50	49	48	48	47	46	46	45	44	44	43	42	42	41	41	40	40	39	38	38	37
35 30	53	53	52	51	51	50	49	49	48	47	46	46	45	44	44	43	42	42	41	41	40	40	39	38
36 0	55	54	54	53	52	51	51	50	49	49	48	47	46	46	45	45	44	43	43	42	41	41	40	40
36 30	57	56	55	54	54	53	52	51	51	50	49	48	48	47	47	46	45	45	44	43	43	42	42	41
37 0	58	57	57	56	55	54	54	53	52	51	51	50	49	48	48	47	47	46	45	45	44	43	43	42
37 30	60	59	58	57	57	56	55	54	54	53	52	51	51	50	49	49	48	47	47	46	46	45	44	44
38 0	61	60	60	59	58	57	57	56	55	54	54	53	52	51	51	50	49	49	48	48	47	46	46	45
38 30	63	62	61	60	60	59	58	57	57	56	55	54	53	53	52	51	51	50	50	49	48	48	47	46
39 0	64	63	63	62	61	60	59	59	58	57	56	56	55	54	54	53	52	52	51	50	50	49	48	48
39 30	66	65	64	63	62	62	61	60	59	58	58	57	56	55	55	54	53	53	52	51	51	50	49	49
40 0	67	66	66	65	64	63	62	61	61	60	59	58	57	57	56	55	55	54	53	53	52	51	51	50
40 30	69	68	67	66	65	64	64	63	62	61	60	60	59	58	57	57	56	55	55	54	53	52	52	51
41 0	70	69	68	67	67	66	65	64	63	62	62	61	60	59	59	58	57	57	56	55	54	54	53	52
41 30	71	70	70	69	68	67	66	65	65	64	63	62	61	61	60	59	58	58	57	56	56	55	54	53
42 0	73	72	71	70	69	68	68	67	66	65	64	63	63	62	61	60	60	59	58	58	57	56	55	55
42 30	74	73	73	72	71	70	69	68	67	66	66	65	64	63	62	62	61	60	59	59	58	57	57	56
43 0	76	75	74	73	72	71	71	70	69	68	67	66	65	65	64	63	62	62	61	60	59	59	58	57
43 30	77	76	75	74	74	73	72	71	70	69	68	67	67	66	65	64	64	63	62	61	61	60	59	58
44 0	78	77	77	76	75	74	73	72	71	70	70	69	68	67	66	66	65	64	63	62	62	61	60	59
44 30	80	79	78	77	76	75	74	74	73	72	71	70	69	68	68	67	66	65	64	64	63	62	61	61
45 0	81	80	79	78	78	77	76	75	74	73	72	71	70	70	69	68	67	66	66	65	64	63	62	62
45 30	83	82	81	80	79	78	77	76	75	74	74	73	72	71	70	69	68	68	67	66	65	64	64	63
46 0	84	83	82	81	80	79	78	77	76	75	75	74	73	72	71	70	70	69	68	67	66	66	65	64
46 30	85	84	83	82	81	80	80	79	78	77	76	75	74	73	72	72	71	70	69	68	68	67	66	65
47 0	87	86	85	84	83	82	81	80	79	78	77	76	75	75	74	73	72	71	70	70	69	68	67	66

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude. 13°												14°											
	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′
° ′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
47 0	87	86	85	84	83	82	81	80	79	78	77	76	75	75	74	73	72	71	70	70	69	68	67	66
47 30	88	87	86	85	84	83	82	81	80	79	78	77	77	76	75	74	73	72	72	71	70	69	68	67
48 0	89	88	87	86	85	84	83	83	82	81	80	79	78	77	76	75	74	74	73	72	71	70	69	69
48 30	90	89	88	87	87	86	85	84	83	82	81	80	79	78	77	76	75	75	74	73	72	71	70	70
49 0	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	77	76	75	74	73	72	71	71
49 30	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	79	78	77	76	75	74	73	73	72
50 0	94	93	92	91	90	89	88	87	86	85	84	83	82	81	81	80	79	78	77	76	75	75	74	73
50 30	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	77	76	75	74
51 0	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	78	77	76	75
51 30	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	80	79	78	77	76
52 0	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	82	81	80	79	78	77
52 30	101	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	84	83	82	81	80	79	78
53 0	102	101	100	99	98	97	96	94	93	92	91	90	89	88	87	86	86	85	84	83	82	81	80	79
53 30	103	102	101	100	99	98	97	96	94	93	92	91	90	89	88	87	87	86	85	84	83	82	81	80
54 0	104	103	102	101	100	99	98	97	96	94	93	92	91	90	90	89	88	87	86	85	84	83	82	81
54 30	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82
55 0	107	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83
55 30	108	107	106	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84
56 0	109	108	107	106	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85
56 30	110	109	108	107	106	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86
57 0	111	110	109	108	107	106	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87
57 30	112	111	110	109	108	107	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88
58 0	113	112	111	110	109	108	106	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89
58 30	114	113	112	111	110	109	107	106	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90
59 0	115	114	113	112	111	110	108	107	106	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91
59 30	116	115	114	113	112	111	109	108	107	106	105	104	103	102	101	100	99	98	97	96	95	94	93	92
60 0	117	116	115	114	113	112	110	109	108	107	106	105	104	103	102	101	100	99	98	97	96	95	94	93
60 30	118	117	116	115	114	112	111	110	109	108	107	106	104	103	102	101	100	99	98	97	96	95	94	93
61 0	119	118	117	116	115	113	112	111	110	109	108	106	105	104	103	102	101	100	99	98	97	96	95	94
61 30	120	119	118	117	116	114	113	112	111	110	108	107	106	105	104	103	102	101	100	99	98	97	96	95
62 0	121	120	119	118	116	115	114	113	112	111	109	108	107	106	105	104	103	102	101	100	99	98	97	96
62 30	122	121	120	119	117	116	115	114	113	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
63 0	123	122	121	119	118	117	116	115	113	112	111	110	109	108	107	106	105	104	102	101	100	99	98	97
63 30	124	123	122	120	119	118	117	116	114	113	112	111	110	108	107	106	105	104	103	102	101	100	99	98
64 0	125	124	123	121	120	119	118	116	115	114	113	112	110	109	108	107	106	105	104	103	102	101	100	99
64 30	126	125	123	122	121	120	118	117	116	115	114	112	111	110	109	108	107	106	105	104	103	102	101	100
65 0	127	125	124	123	122	120	119	118	117	116	114	113	112	111	110	109	108	107	106	105	104	102	101	100
65 30	127	126	125	124	123	121	120	119	118	116	115	114	113	112	111	110	109	108	106	105	104	103	102	101
66 0	128	127	126	125	123	122	121	120	119	117	116	115	114	113	112	110	109	108	107	106	105	104	103	102
66 30	129	128	127	125	124	123	122	120	119	118	117	116	114	113	112	111	110	109	108	107	106	105	104	103
67 0	130	129	128	126	125	124	123	121	120	119	118	116	115	114	113	112	111	110	109	108	107	105	104	103
68 0	132	130	129	128	127	125	124	123	122	120	119	118	117	115	114	113	112	111	110	109	108	107	106	105
69 0	133	132	131	129	128	127	126	124	123	122	120	119	118	117	116	115	114	113	111	110	109	108	107	106
70 0	135	133	132	131	130	128	127	126	125	123	122	121	120	118	117	116	115	114	113	112	111	110	109	107
71 0	136	135	133	132	131	130	128	127	126	124	123	122	121	120	118	117	116	115	114	113	112	111	110	109
72 0	137	136	135	133	132	131	129	128	127	126	124	123	122	121	120	118	117	116	115	114	113	112	111	110
73 0	138	137	136	135	133	132	131	129	128	127	125	124	123	122	121	120	118	117	116	115	114	113	112	111
74 0	140	138	137	136	134	133	132	130	129	128	126	125	124	123	122	121	119	118	117	116	115	114	113	112
75 0	141	139	138	137	135	134	133	131	130	129	127	126	125	124	123	122	120	119	118	117	116	115	114	113
76 0	142	140	139	138	136	135	134	132	131	130	128	127	126	125	124	123	121	120	119	118	117	116	115	114
77 0	143	141	140	139	137	136	135	133	132	131	129	128	127	126	125	123	122	121	120	119	118	117	115	114
78 0	144	142	141	140	138	137	136	134	133	132	130	129	128	126	125	124	123	122	121	120	118	117	116	115
79 0	144	143	142	140	139	138	136	135	134	132	131	130	128	127	126	125	124	123	122	120	119	118	117	116
80 0	145	144	142	141	140	138	137	136	135	133	132	131	129	128	127	126	125	123	122	121	120	119	118	116
81 0	146	144	143	142	141	139	138	137	135	134	133	131	130	129	128	126	125	124	123	122	121	119	118	117
82 0	147	145	144	142	141	140	138	137	136	134	133	132	130	129	128	127	126	125	123	122	121	120	119	118
84 0	147	146	145	143	142	141	139	138	137	135	134	133	131	130	129	128	127	125	124	123	122	121	120	118
86 0	148	147	145	144	143	141	140	139	137	136	135	133	132	131	130	128	127	126	125	124	123	121	120	119
88 0	149	147	146	144	143	142	140	139	138	136	135	134	132	131	130	129	128	127	125	124	123	122	121	119
90 0	149	147	146	145	143	142	141	139	138	137	135	134	133	131	130	129	128	127	126	124	123	122	121	120

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude.																					
	15°						16°						17°						18°			
	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
15° 0′	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
16 0	0	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
17 0	1	1	1	1	0	0	0	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…	…
18 0	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19 0	3	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0
20 0	4	4	4	4	3	3	3	3	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0	0
21 0	6	6	5	5	4	4	4	4	3	3	3	2	2	2	2	2	2	1	1	1	1	0	0	0
22 0	8	8	7	7	6	6	5	5	4	4	4	3	3	3	3	3	2	2	2	2	2	2	1	1
22 30	9	9	8	8	7	7	6	6	5	5	5	4	4	3	3	3	2	2	2	2	2	2	1	1
23 0	10	10	9	9	8	8	7	7	6	6	6	5	5	4	4	4	3	3	3	3	3	3	2	2
23 30	11	11	10	10	9	9	8	8	7	7	6	6	5	5	5	4	4	4	4	4	4	3	3	3
24 0	12	12	11	11	10	10	9	9	8	8	7	7	6	6	5	5	5	4	4	4	4	3	3	3
24 30	13	12	12	11	10	10	9	9	8	8	8	7	7	7	6	6	6	5	5	5	5	4	4	4
25 0	14	13	13	12	11	11	10	10	9	9	9	8	8	8	7	7	7	6	6	6	5	5	5	4
25 30	15	14	14	13	12	12	11	11	10	10	10	9	9	9	8	8	8	7	7	7	6	6	6	5
26 0	16	15	15	14	13	13	12	12	11	11	10	10	9	9	8	8	8	7	7	7	7	6	6	6
26 30	17	16	16	15	14	14	13	13	12	12	11	11	10	10	9	9	8	8	7	7	7	6	6	6
27 0	18	17	17	16	15	15	14	14	13	13	12	12	11	11	10	10	9	9	8	8	8	7	7	7
27 30	19	18	18	17	16	16	15	15	14	14	13	13	12	12	11	11	10	10	9	9	9	8	8	8
28 0	21	20	20	19	18	18	17	16	16	15	14	14	13	13	12	12	11	11	10	10	9	9	9	8
28 30	22	21	21	20	19	19	18	17	17	16	15	15	14	14	13	13	12	12	11	11	10	10	10	9
29 0	23	22	22	21	20	20	19	18	18	17	16	16	15	15	14	14	13	13	12	12	11	11	11	10
29 30	24	23	23	22	21	21	20	19	19	18	17	17	16	15	15	14	13	13	12	12	11	11	11	10
30 0	25	24	24	23	22	22	21	20	20	19	18	18	17	16	16	15	14	14	13	13	12	12	12	11
30 30	26	25	25	24	23	23	22	21	21	20	19	19	18	17	17	16	15	15	14	14	13	13	13	12
31 0	28	27	26	26	25	24	23	22	22	21	20	20	19	18	18	17	16	16	15	15	14	14	14	13
31 30	29	28	27	27	26	25	24	23	23	22	21	21	20	19	19	18	17	17	16	16	15	15	15	14
32 0	30	29	28	28	27	26	25	24	24	23	22	22	21	20	20	19	18	18	17	17	16	16	16	15
32 30	31	30	29	29	28	27	26	25	25	24	23	23	22	21	21	20	19	19	18	18	17	17	17	16
33 0	32	31	30	30	29	28	27	26	26	25	24	24	23	22	22	21	20	20	19	18	18	17	17	16
33 30	33	32	31	31	30	29	28	27	27	26	25	25	24	23	22	22	21	20	20	19	19	18	18	17
34 0	35	34	33	33	32	31	30	29	28	28	27	26	25	24	23	23	22	21	20	20	19	19	19	18
34 30	36	35	34	34	33	32	31	30	29	29	28	27	26	25	24	24	23	22	21	21	20	20	20	19
35 0	37	36	35	35	34	33	32	31	30	30	29	28	27	26	25	25	24	23	22	22	21	21	21	20
35 30	38	37	36	36	35	34	33	32	31	31	30	29	28	27	26	26	25	24	23	23	22	22	21	21
36 0	40	39	38	37	36	35	34	33	32	32	31	30	29	28	27	27	26	25	24	23	23	22	22	21
36 30	41	40	39	38	37	36	35	34	33	33	32	31	30	29	28	28	27	26	25	24	24	23	22	22
37 0	42	41	40	39	38	37	36	35	34	34	33	32	31	30	29	29	28	27	26	25	25	24	23	23
37 30	43	42	41	40	39	38	37	36	35	35	34	33	32	31	30	29	28	27	27	26	26	25	24	24
38 0	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	28	27	27	26	25	25
38 30	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	29	28	28	27	26	26
39 0	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	30	29	28	27	27	26
39 30	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	31	30	29	28	27	27
40 0	50	49	48	47	45	44	43	42	41	40	39	38	37	36	35	34	33	32	32	31	30	29	28	27
40 30	51	50	49	48	46	45	44	43	42	41	40	39	38	37	36	35	34	33	33	32	31	30	29	28
41 0	52	51	50	49	47	46	45	44	43	42	41	40	39	38	37	37	36	35	34	33	32	31	30	29
41 30	53	52	51	50	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	33	32	31	30
42 0	55	54	53	52	50	49	48	47	46	45	43	42	41	40	39	38	37	36	35	34	33	32	31	31
42 30	56	55	54	53	51	50	49	48	47	46	44	43	42	41	40	39	38	37	36	35	34	33	32	31
43 0	57	56	55	54	52	51	50	49	48	47	45	44	43	42	41	40	39	38	37	36	35	34	33	32
43 30	58	57	56	55	53	52	51	50	49	48	46	45	44	43	42	41	40	39	38	37	36	35	34	33
44 0	59	58	57	56	54	53	52	51	50	49	47	46	45	44	43	42	41	40	39	38	37	36	35	34
44 30	60	59	58	57	55	54	53	52	51	50	48	47	46	45	44	43	42	41	40	39	38	37	36	35
45 0	62	61	59	58	57	55	54	53	52	51	49	48	47	46	45	44	43	42	41	40	39	38	37	36
45 30	63	62	60	59	58	56	55	54	53	52	50	49	48	47	46	45	44	43	42	41	40	39	38	37
46 0	64	63	61	60	59	57	56	55	54	53	51	50	49	48	47	46	45	44	43	42	41	40	39	38
46 30	65	64	62	61	60	58	57	56	55	54	52	51	50	49	48	47	46	45	44	43	42	41	40	39
47 0	66	65	63	62	61	59	58	57	56	55	53	52	51	50	49	48	47	46	45	44	43	42	41	40
47 30	67	66	64	63	62	60	59	58	57	56	54	53	52	51	50	49	47	46	45	44	43	42	41	41
48 0	68	67	65	64	63	61	60	59	58	57	55	54	53	52	51	50	48	47	46	45	44	43	42	42

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude.																							
	15°						16°						17°						18°					
	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
48° 0′	68	67	65	64	63	61	60	59	58	57	55	54	53	52	51	50	48	47	46	45	44	43	42	42
48 30	69	68	66	65	64	62	61	60	59	58	56	55	54	53	52	51	49	48	47	46	45	44	43	42
49 0	71	70	68	67	65	64	62	61	60	59	57	56	55	54	53	52	50	49	48	47	46	45	44	43
49 30	72	71	69	68	66	65	63	62	61	60	58	57	56	55	54	53	51	50	49	48	47	46	45	44
50 0	73	72	70	69	67	66	64	63	62	61	59	58	57	56	55	54	52	51	50	49	48	47	46	45
50 30	74	73	71	70	68	67	65	64	62	61	60	58	57	56	55	54	52	51	50	49	48	47	46	45
51 0	75	74	72	71	69	68	66	65	63	62	61	59	58	57	56	55	53	52	51	50	49	48	47	46
51 30	76	75	73	72	70	69	67	66	64	63	62	60	59	58	57	56	54	53	52	51	50	49	48	47
52 0	77	76	74	73	71	70	68	67	65	64	63	61	60	59	58	57	55	54	53	52	51	50	49	48
52 30	78	77	75	74	72	71	69	68	66	65	64	62	61	60	59	58	56	55	54	53	52	51	50	49
53 0	79	78	76	75	73	72	70	69	67	66	65	63	62	61	60	59	57	56	55	54	53	52	51	50
53 30	80	79	77	76	74	73	71	70	68	67	66	64	63	62	60	59	58	56	55	54	53	52	51	50
54 0	81	80	78	77	75	74	72	71	69	68	67	65	64	63	61	60	59	57	56	55	54	53	52	51
54 30	82	81	79	78	76	75	73	72	70	69	67	66	64	63	62	61	59	58	57	56	55	54	53	52
55 0	83	82	80	79	77	76	74	73	71	70	68	66	65	64	63	62	60	59	58	57	56	55	54	53
55 30	84	83	81	80	78	77	75	74	72	71	69	67	66	65	64	63	61	59	58	57	56	56	55	54
56 0	85	84	82	81	79	78	76	75	73	72	70	68	67	66	65	64	62	60	59	58	57	56	55	54
56 30	86	85	83	82	80	79	77	76	74	73	71	69	68	67	66	65	63	61	60	59	58	57	56	55
57 0	87	86	84	83	81	80	78	77	75	74	72	70	69	68	67	66	64	62	61	60	59	58	56	55
57 30	88	87	85	84	82	81	79	78	76	75	73	71	70	69	68	67	65	63	62	61	60	59	57	56
58 0	88	87	85	84	82	81	79	78	76	75	73	71	70	69	68	67	65	63	62	61	60	59	58	57
58 30	89	88	86	85	83	82	80	79	77	76	74	72	71	70	69	68	66	64	63	62	61	60	58	57
59 0	90	89	87	86	84	83	81	80	78	77	75	73	72	71	70	69	67	65	64	63	62	61	59	58
59 30	91	90	88	87	85	84	82	80	79	77	75	74	72	71	70	69	67	65	64	63	62	61	60	59
60 0	92	91	89	88	86	85	83	81	80	78	76	75	73	72	71	70	68	66	65	64	63	62	61	60
60 30	93	91	90	88	86	85	83	82	80	79	77	75	74	73	72	71	69	67	66	65	64	63	62	61
61 0	94	92	91	89	87	86	84	83	81	80	78	76	75	74	73	72	70	68	67	66	65	64	62	61
61 30	95	93	92	90	88	87	85	83	82	80	78	77	75	74	73	72	70	68	67	66	65	64	63	62
62 0	96	94	93	91	89	88	86	84	83	81	79	78	76	75	74	73	71	69	68	67	66	65	63	62
62 30	96	94	93	91	89	88	86	84	83	81	79	78	76	75	74	73	71	69	68	67	66	65	64	63
63 0	97	95	94	92	90	89	87	85	84	82	80	79	77	76	75	74	72	70	69	68	67	66	64	63
63 30	98	96	95	93	91	90	88	86	85	83	81	80	78	77	76	75	73	71	70	69	68	67	65	64
64 0	99	97	96	94	92	91	89	87	86	84	82	81	79	78	77	76	74	72	71	70	68	67	66	64
64 30	99	97	96	94	92	91	89	87	86	84	82	81	79	78	77	76	74	72	71	70	69	68	66	65
65 0	100	98	97	95	93	92	90	88	87	85	83	82	80	79	78	77	75	73	72	71	69	68	67	65
66	101	99	98	96	94	93	91	89	88	86	84	83	81	80	79	78	76	74	73	72	70	69	68	66
67	103	101	100	98	96	95	93	91	90	88	86	85	83	82	80	79	77	75	74	73	71	70	69	67
68	104	102	101	99	97	96	94	92	91	89	87	86	84	83	81	80	78	76	75	74	72	71	70	68
69	105	103	102	100	98	97	95	93	92	90	88	87	85	84	82	81	79	77	76	75	73	72	71	69
70	107	105	103	102	100	98	96	94	93	91	89	88	86	85	83	82	80	78	77	76	74	73	72	70
71	108	106	104	103	101	99	97	95	94	92	90	89	87	86	84	83	81	79	78	77	75	74	73	71
72	109	107	105	104	102	100	98	96	95	93	91	90	88	87	85	84	82	80	79	78	76	75	74	72
73	110	108	106	105	103	101	99	97	96	94	92	91	89	88	86	85	83	81	80	79	77	76	75	73
74	111	109	107	106	104	102	100	98	97	95	93	92	90	89	87	86	84	82	81	80	78	77	76	74
75	112	110	108	107	105	103	101	99	97	96	94	92	90	89	87	86	84	82	81	80	78	77	76	74
76	113	111	109	108	106	104	102	100	98	97	95	93	91	90	88	87	85	83	82	81	79	78	77	75
77	114	112	110	108	106	104	102	100	99	97	95	94	92	91	89	88	86	84	83	82	80	79	77	75
78	115	113	111	109	107	105	103	101	99	98	96	94	92	91	89	88	86	84	83	82	80	79	78	76
79	115	113	111	110	108	106	104	102	100	99	97	95	93	92	90	89	87	85	84	83	81	80	79	77
80	116	114	112	111	109	107	105	103	101	100	98	96	94	92	91	89	87	86	84	83	81	80	79	77
81	117	115	113	111	109	107	105	103	101	100	98	96	94	93	91	90	88	86	85	84	82	81	80	78
82	117	115	113	112	110	108	106	104	102	101	99	97	95	94	92	91	89	87	86	85	83	82	80	78
83	118	116	114	112	110	108	106	104	102	101	99	97	95	94	92	91	89	87	86	85	83	82	81	79
84	118	116	114	112	110	108	106	104	103	101	99	98	96	94	93	91	89	87	86	85	83	82	81	79
85	119	117	115	113	111	109	107	105	103	102	100	98	96	95	93	92	90	88	87	86	84	83	81	80
86	119	117	115	113	111	109	107	105	103	102	100	98	96	95	93	92	90	88	87	86	84	83	82	80
87	119	117	115	113	111	109	107	105	103	102	100	98	96	95	93	92	90	88	87	86	84	83	82	80
88	119	117	115	113	111	109	107	105	103	102	100	98	96	95	93	92	90	88	87	86	84	83	82	80
89	119	117	115	113	111	109	107	105	104	102	100	99	97	95	94	92	90	89	87	86	84	83	82	80
90	119	117	115	114	112	110	108	106	104	103	101	99	97	95	94	92	90	89	87	86	84	83	82	80

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude.																							
	19°						20°						21°						22°					
	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
19° 0′	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
20 0	0	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
21 0	0	0	0	0	0	0	0	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…	…
22 0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	…	…	…	…	…
23 0	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
23 30	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24 0	3	3	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24 30	3	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25 0	4	4	4	4	3	3	3	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
25 30	5	5	5	5	4	4	4	4	3	3	3	2	2	2	2	2	1	1	1	1	1	1	1	1
26 0	6	6	5	5	5	4	4	4	3	3	3	2	2	2	2	2	2	2	2	2	2	2	1	1
26 30	6	6	5	5	5	4	4	4	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	1
27 0	7	7	6	6	6	5	5	5	4	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2
27 30	7	7	6	6	6	5	5	5	4	4	4	3	3	3	3	3	2	2	2	2	2	2	2	2
28 0	8	8	7	7	7	6	6	6	5	5	5	4	4	4	4	4	3	3	3	3	3	3	2	2
28 30	8	8	7	7	7	6	6	6	5	5	5	4	4	4	4	4	3	3	3	3	3	3	3	2
29 0	9	9	8	8	8	7	7	7	6	6	6	5	5	5	5	5	4	4	4	4	4	4	3	3
29 30	10	10	9	9	9	8	8	8	7	7	7	6	6	6	5	5	5	4	4	4	4	4	4	4
30 0	11	11	10	10	10	9	9	9	8	8	8	7	7	7	6	6	6	5	5	5	5	5	4	4
30 30	11	11	11	11	10	10	10	10	9	9	9	8	8	8	7	7	7	6	6	6	6	6	5	5
31 0	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7	7	7	6	6	6	6	6	5	5
31 30	13	13	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7	7	7	7	6	6	5
32 0	14	14	13	13	12	11	11	11	10	10	10	9	9	9	8	8	8	7	7	7	7	7	6	6
32 30	14	14	13	13	12	11	11	11	10	10	10	9	9	9	9	9	8	8	8	8	7	7	7	6
33 0	15	15	14	14	13	12	12	12	11	11	11	10	10	10	10	10	9	9	9	9	8	8	8	7
33 30	16	16	15	15	14	13	13	13	12	12	12	11	11	11	11	11	10	10	10	10	9	9	9	8
34 0	17	17	16	16	15	14	14	14	13	13	13	12	12	12	11	11	11	10	10	10	9	9	9	8
34 30	18	18	17	17	16	15	15	15	14	14	14	13	13	13	12	12	12	11	11	11	10	10	10	9
35 0	19	19	18	18	17	16	16	16	15	15	14	13	13	13	12	12	12	11	11	11	10	10	10	9
35 30	20	20	19	19	18	17	17	17	16	16	15	14	14	14	13	13	13	12	12	12	11	11	11	10
36 0	20	20	19	19	18	17	17	17	16	16	16	15	15	15	14	14	13	12	12	12	11	11	11	10
36 30	21	21	20	20	19	18	18	18	17	17	17	16	16	16	15	15	14	13	13	13	12	12	12	11
37 0	22	22	21	21	20	19	19	19	18	18	17	16	16	16	15	15	15	14	14	14	13	13	12	11
37 30	23	23	22	22	21	20	20	20	19	19	18	17	17	17	16	16	16	15	15	15	14	14	13	12
38 0	24	23	23	22	21	21	20	20	19	19	18	17	17	17	16	16	16	15	15	15	14	14	14	13
38 30	25	24	24	23	22	22	21	21	20	20	19	18	18	18	17	17	17	16	16	16	15	15	15	14
39 0	25	25	24	24	23	22	22	22	21	21	20	19	19	19	18	18	17	16	16	16	15	15	15	14
39 30	26	25	25	24	23	23	22	22	21	21	20	19	19	19	18	18	17	16	16	16	15	15	15	14
40 0	27	26	26	25	24	24	23	22	21	21	20	19	20	20	19	19	18	17	17	17	16	16	16	15
40 30	28	27	27	26	25	25	24	23	22	22	21	20	21	21	20	20	19	18	18	18	17	17	17	16
41 0	29	28	28	27	26	26	25	24	23	23	22	21	22	22	21	21	20	19	19	19	18	18	17	16
41 30	30	29	29	28	27	27	26	25	24	24	23	22	23	23	22	22	21	20	20	20	19	19	18	17
42 0	30	29	29	28	27	27	26	25	24	24	23	22	23	23	22	22	21	20	20	20	19	19	18	17
42 30	31	30	30	29	28	28	27	26	25	25	24	23	24	24	23	23	22	21	21	21	20	20	19	18
43 0	32	31	31	30	29	29	28	27	27	26	25	25	24	24	23	23	22	21	21	21	20	20	20	19
43 30	33	32	32	31	30	30	29	28	28	27	26	26	25	25	24	24	23	22	22	22	21	21	21	20
44 0	34	33	33	32	31	31	30	29	29	28	27	27	26	26	25	25	24	23	23	23	22	22	21	20
44 30	35	34	34	33	32	32	31	30	30	29	28	28	27	27	26	26	25	24	24	24	23	23	22	21
45 0	36	35	34	34	33	32	51	30	30	29	28	28	27	27	26	26	25	24	24	24	23	23	22	21
45 30	37	36	35	35	34	33	32	31	31	30	29	29	28	28	27	27	26	25	25	25	24	24	23	22
46 0	38	37	36	36	35	34	33	32	32	31	30	30	29	28	28	27	26	26	25	25	24	24	23	22
46 30	39	38	37	37	36	35	34	33	33	32	31	31	30	29	29	28	27	27	26	26	25	25	24	23
47 0	39	38	37	37	36	35	34	33	33	32	31	31	30	30	29	29	28	28	27	27	26	26	25	24
47 30	40	39	38	38	37	36	35	34	34	33	32	32	31	31	30	30	29	29	28	28	27	27	26	25
48 0	41	40	39	39	38	37	36	35	35	34	33	33	32	31	31	30	29	29	28	28	27	27	26	25
48 30	41	40	39	39	38	37	36	35	35	34	33	33	32	31	31	30	29	29	28	28	27	27	26	25
49 0	42	41	40	40	39	38	37	36	36	35	34	34	33	32	32	31	30	30	29	29	28	28	27	26
49 30	43	42	41	41	40	39	38	37	37	36	35	35	34	33	33	32	31	31	30	30	29	29	28	27
50 0	44	43	42	42	41	40	39	38	37	37	36	35	34	33	33	32	31	31	30	30	29	29	28	27
50 30	44	43	42	42	41	40	39	38	38	37	36	36	35	34	34	33	32	32	31	31	30	30	29	28

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude.																					
	19°						20°						21°						22°			
	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′	0′	10′	20′	30′	40′	50′
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
50° 0′	44	43	42	42	41	40	39	38	37	37	36	35	34	33	33	32	31	31	30	30	29	29	28	27
50 30	44	43	42	42	41	40	39	38	38	37	36	36	35	34	34	33	32	32	31	31	30	30	29	28
51 0	45	44	43	43	42	41	40	39	39	38	37	37	36	35	35	34	33	33	32	32	31	31	30	29
51 30	46	45	44	43	42	41	40	39	39	38	37	37	36	35	35	34	33	33	32	32	31	31	30	29
52 0	47	46	45	44	43	42	41	40	40	39	38	38	37	36	36	35	34	34	33	33	32	32	31	30
52 30	48	47	46	45	44	43	42	41	41	40	39	39	38	37	37	36	35	35	34	34	33	33	32	31
53 0	49	48	47	46	45	44	43	42	41	41	40	39	38	37	37	36	35	35	34	34	33	33	32	31
53 30	49	48	47	46	45	44	43	42	42	41	40	40	39	38	38	37	36	36	35	35	34	34	33	32
54 0	50	49	48	47	46	45	44	43	43	42	41	41	40	39	39	38	37	37	36	35	35	34	33	33
54 30	51	50	49	48	47	46	45	44	44	43	42	42	41	40	40	39	38	38	37	36	36	35	34	34
55 0	52	51	50	49	48	47	46	45	44	44	43	42	41	40	40	39	38	38	37	36	36	35	34	34
55 30	53	52	51	50	49	48	47	46	45	44	43	42	41	40	40	39	38	38	37	36	36	35	34	34
56 0	53	52	51	50	49	48	47	46	45	45	44	43	42	41	41	40	39	39	38	37	37	36	35	35
56 30	54	53	52	51	50	49	48	47	46	45	44	43	42	41	41	40	39	39	38	37	37	36	35	35
57 0	54	53	52	52	51	50	49	48	47	46	45	44	43	42	42	41	40	40	39	38	38	37	36	36
57 30	55	54	53	52	51	50	49	48	47	47	46	45	44	43	43	42	41	41	40	39	39	38	37	37
58 0	56	55	54	53	52	51	50	49	48	48	47	46	45	44	43	43	42	41	40	39	39	38	37	37
58 30	56	55	54	53	52	51	50	49	48	48	47	46	45	44	44	43	42	42	41	40	40	39	38	38
59 0	57	56	55	54	53	52	51	50	49	49	48	47	46	45	45	44	43	43	42	41	40	40	39	38
59 30	58	57	56	55	54	53	52	51	50	50	49	48	47	46	46	45	44	44	43	42	41	41	40	39
60 0	59	58	57	56	54	53	52	51	50	50	49	48	47	46	46	45	44	44	43	42	42	41	40	40
60 30	60	59	58	57	55	54	53	52	51	50	49	48	47	46	46	45	44	44	43	42	42	41	40	40
61 0	60	59	58	57	56	55	54	53	52	51	50	49	48	47	47	46	45	45	44	43	43	42	41	41
61 30	61	60	59	58	57	56	55	54	53	52	51	50	49	48	48	47	46	46	45	44	44	43	42	42
62 0	61	60	59	58	57	56	55	54	53	52	51	50	49	48	48	47	46	46	45	44	44	43	42	42
62 30	62	61	60	59	58	57	56	55	54	53	52	51	50	49	49	48	47	47	46	45	45	44	43	43
63 0	62	61	60	59	58	57	56	55	54	53	52	51	50	49	49	48	47	47	46	45	45	44	43	43
63 30	63	62	61	60	59	58	57	56	55	54	53	52	51	50	50	49	48	48	47	46	45	45	44	43
64 0	63	62	61	60	59	58	57	56	55	54	53	52	51	50	50	49	48	48	47	46	45	45	44	43
64 30	64	63	62	61	60	59	58	57	56	55	54	53	52	51	51	50	49	49	48	47	46	46	45	44
65 0	64	63	62	61	60	59	58	57	56	55	54	53	52	51	51	50	49	49	48	47	46	46	45	44
65 30	64	63	62	61	60	59	58	57	56	55	54	53	52	51	51	50	49	49	48	47	46	46	45	45
66 0	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	51	50	49	48	47	46	46	45	45
66 30	65	64	63	62	61	60	59	58	57	56	55	54	53	52	52	51	50	50	49	48	47	47	46	46
67 0	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	52	51	50	49	48	47	47	46	46
67 30	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	52	51	50	49	48	47	47	46	46
68 0	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	53	52	51	50	49	48	48	47	47
68 30	67	66	65	64	63	62	61	60	59	59	58	57	56	55	54	54	53	52	51	50	49	49	48	47
69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	54	53	52	51	50	49	49	48	47
70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	55	54	53	52	51	50	50	49	48
71	70	69	68	67	65	64	63	62	61	61	60	59	58	57	56	56	55	54	53	52	51	51	50	49
72	71	70	69	68	66	65	64	63	62	61	60	59	58	57	56	56	55	54	53	52	51	51	50	49
73	72	71	70	69	67	66	65	64	63	62	61	60	59	58	57	57	56	55	54	53	52	52	51	50
74	73	72	71	70	68	67	66	65	64	63	62	61	60	59	58	58	57	56	55	54	53	53	52	51
75	73	72	71	70	68	67	66	65	64	63	62	61	60	59	58	58	57	56	55	54	53	53	52	51
76	74	73	72	71	69	68	67	66	65	64	63	62	61	60	59	59	58	57	56	55	54	53	52	51
77	74	73	72	71	69	68	67	66	65	64	63	62	61	60	59	59	58	57	56	55	54	54	53	52
78	75	74	73	72	70	69	68	67	66	65	64	63	62	61	60	60	59	58	57	56	55	54	53	52
79	76	75	74	73	71	70	69	68	67	66	64	63	62	61	60	60	59	58	57	56	55	55	54	53
80	76	75	74	73	72	71	70	69	68	67	65	64	63	62	61	61	60	59	58	57	56	56	55	54
81	77	76	75	74	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	56	55	54
82	77	76	75	74	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	56	55	54
83	78	77	76	75	73	72	71	70	69	68	66	65	64	63	62	62	61	60	59	58	57	57	56	55
84	78	77	76	75	73	72	71	70	69	68	66	65	64	63	62	62	61	60	59	58	57	57	56	55
85	78	77	76	75	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	57	56	55
86	79	78	76	75	74	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	57	56	55
87	79	78	76	75	74	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	57	56	55
88	79	78	77	76	74	73	72	71	70	69	67	66	65	64	63	63	62	61	60	59	58	57	56	55
89	79	78	77	76	74	73	72	71	70	69	67	66	65	64	63	63	62	61	60	59	58	57	56	55
90	79	78	77	76	74	73	72	71	70	69	67	66	65	64	63	63	62	61	60	59	58	57	56	55

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude.																							
	23°				24°				25°				26°				27°				28°			
	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′	0′	15′	30′	45′
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
23°	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
24	1	1	0	0	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
25	1	1	1	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
26	1	1	1	1	1	1	1	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…	…
27	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	…	…	…	…	…	…	…
28	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	…	…	…
29	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
30	4	4	4	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
31	5	5	5	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1
32	6	6	5	4	4	4	4	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	1	1
33	7	7	6	5	5	5	5	4	4	4	4	3	3	3	3	2	2	2	2	2	2	2	2	1
34	8	8	7	6	6	6	6	5	5	5	5	4	4	4	4	3	3	3	3	2	2	2	2	2
35	9	9	8	7	7	7	7	6	6	6	6	5	5	5	5	4	4	4	4	3	3	3	3	2
36	10	10	10	9	9	9	8	7	7	7	7	6	6	6	5	4	4	4	4	3	3	3	3	3
37	11	11	11	10	10	10	9	8	8	8	7	6	6	6	6	5	5	5	5	4	4	4	4	3
38	13	13	12	11	11	11	10	9	9	9	8	7	7	7	7	6	6	6	6	5	5	5	5	4
39	14	14	13	12	12	12	11	10	10	10	9	8	8	8	8	7	7	7	6	5	5	5	5	5
40	15	15	14	13	13	13	12	11	11	11	10	9	9	9	9	8	8	8	7	6	6	6	6	5
41	16	16	15	14	14	14	13	12	12	12	11	10	10	10	10	9	9	9	8	7	7	7	7	6
42	17	17	16	15	15	15	14	13	13	13	12	11	11	11	11	10	10	10	9	8	8	8	8	7
43	19	18	18	17	16	16	15	14	14	14	13	12	12	12	12	11	11	11	10	9	9	9	8	8
44	20	19	19	18	17	17	16	15	15	15	14	13	13	13	12	11	11	11	11	10	9	9	9	8
45	21	20	20	19	18	18	17	16	16	16	15	14	14	14	13	12	12	12	12	11	10	10	10	9
46	22	21	21	20	19	19	18	17	17	17	16	15	15	15	14	13	13	13	13	12	11	11	11	10
47	24	23	23	22	21	20	20	19	18	18	17	16	16	16	15	14	14	14	14	13	12	12	11	11
48	25	24	24	23	22	21	21	20	19	19	18	17	17	17	16	15	15	15	15	14	13	13	12	12
49	26	25	25	24	23	22	22	21	20	20	19	18	18	17	17	16	15	15	15	14	13	13	12	12
50	27	26	26	25	24	23	23	22	21	20	20	19	18	18	17	16	16	15	15	14	13	13	12	12
51	29	28	27	26	25	24	24	23	22	21	21	20	19	19	18	17	17	16	16	15	14	14	13	13
52	30	29	28	27	26	25	25	24	23	22	22	21	20	20	19	18	18	17	17	16	15	15	14	14
53	31	30	29	28	27	26	26	25	24	23	23	22	21	21	20	19	19	18	18	17	16	16	15	15
54	32	31	30	29	28	27	27	26	25	24	24	23	22	22	21	20	20	19	19	18	17	17	16	16
55	33	32	31	30	29	28	28	27	26	25	25	24	23	23	22	21	21	20	20	19	18	18	17	17
56	34	33	32	31	30	29	29	28	27	26	26	25	24	23	23	22	21	20	20	19	18	18	17	17
57	35	34	33	32	31	30	30	29	28	27	27	26	25	24	24	23	22	21	21	20	19	19	18	18
58	36	35	34	33	32	31	31	30	29	28	28	27	26	25	25	24	23	22	22	21	20	19	19	19
59	37	36	36	35	34	33	32	31	30	29	29	28	27	26	26	25	24	23	23	22	21	20	20	20
60	39	38	37	36	35	34	33	32	31	30	30	29	28	27	27	26	25	24	24	23	22	21	21	20
61	40	39	38	37	36	35	34	33	32	31	31	30	29	28	28	27	26	25	25	24	23	22	22	21
62	41	40	39	38	37	36	35	34	33	32	32	31	30	29	29	28	27	26	25	24	23	23	22	22
63	42	41	40	39	38	37	36	35	34	33	32	31	30	29	29	28	27	26	26	25	24	23	23	22
64	42	41	40	39	38	37	36	35	34	33	33	32	31	30	30	29	28	27	27	26	25	24	24	23
65	43	42	41	40	39	38	37	36	35	34	34	33	32	31	31	30	29	28	28	27	26	25	25	24
66	44	43	42	41	40	39	38	37	36	35	34	33	32	31	31	30	29	28	28	27	26	25	25	24
67	45	44	43	42	41	40	39	38	37	36	35	34	33	32	32	31	30	29	29	28	27	26	26	25
68	46	45	44	43	42	41	40	39	38	37	36	35	34	33	33	32	30	29	29	28	27	26	26	25
69	46	45	44	43	42	41	40	39	38	37	36	35	34	33	33	32	31	30	29	28	27	27	26	26
70	47	46	45	44	43	42	41	40	39	38	37	36	35	34	34	33	32	31	30	29	28	27	27	26
71	48	47	46	44	43	42	41	40	39	38	37	36	35	34	34	33	32	31	30	29	28	27	27	26
72	48	47	46	45	44	43	42	41	40	39	38	37	36	35	35	34	33	32	31	30	29	28	28	27
73	49	48	47	45	44	43	42	41	40	39	39	38	37	36	35	34	33	32	31	30	29	29	28	28
74	50	49	48	46	45	44	43	42	41	40	39	38	37	36	36	35	34	33	32	31	30	29	29	28
75	50	49	48	46	45	44	43	42	41	40	39	38	37	36	36	35	34	33	32	31	30	29	29	28
76	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	30	29	28
77	51	50	49	47	46	45	44	43	42	41	40	39	38	37	37	36	35	34	33	32	31	30	30	29
78	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	30	29
79	52	51	50	48	47	46	45	44	43	42	41	40	39	38	38	37	36	35	34	33	32	31	31	30
80	53	52	51	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	31	30
85	54	53	52	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	32	31
90	55	54	53	51	50	49	48	47	46	45	44	42	41	40	39	38	37	36	36	35	33	32	32	31

TABLE V.

The Auxiliary Arc for Table VI.

Greater App. Alt.	The Less Apparent Altitude.																							
	29°		30°		31°		32°		33°		34°		35°		36°		37°		38°		39°		40°	
	0′	30′	0′	30′	0′	30′	0′	30′	0′	30′	0′	30′	0′	30′	0′	30′	0′	30′	0′	30′	0′	30′	0′	30′
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
29°	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
30	1	1	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
34	2	2	1	1	1	1	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…	…	…	…
36	3	3	2	2	2	2	1	1	0	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…
38	4	4	3	3	3	3	2	2	1	1	1	0	0	0	0	0	0	0	0	…	…	…	…	…
39	5	5	4	4	3	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	…	…	…
40	5	5	5	4	3	3	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
41	6	6	5	5	4	4	3	3	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0
42	7	7	6	5	4	4	3	3	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0
43	7	7	6	5	4	4	3	3	3	3	3	2	2	2	2	2	1	1	1	1	1	1	0	0
44	8	8	7	6	5	5	4	4	3	3	3	2	2	2	2	2	1	1	1	1	1	1	0	0
45	9	8	7	7	6	5	5	5	4	4	3	3	3	3	2	2	2	1	1	1	1	1	0	0
46	10	9	8	7	6	6	5	5	4	4	3	3	3	3	2	2	2	2	1	1	1	1	1	0
47	10	9	8	8	7	7	6	6	5	5	4	3	3	3	3	3	2	2	2	1	1	1	1	1
48	11	10	9	8	7	7	6	6	5	5	4	4	4	4	3	3	2	2	2	2	2	2	1	1
49	11	10	9	9	8	8	7	7	6	6	5	4	4	4	3	3	3	3	2	2	2	2	1	1
50	11	11	10	9	9	8	7	7	6	6	6	5	5	4	4	4	3	3	3	3	2	2	2	1
51	12	12	11	10	9	9	8	8	7	7	6	5	5	5	4	4	4	3	3	3	2	2	2	2
52	13	12	11	10	10	9	9	8	7	7	6	6	6	5	5	5	4	4	3	3	3	3	2	2
53	14	13	12	11	11	10	9	9	8	8	7	7	6	5	5	5	4	4	4	4	3	3	2	2
54	15	14	13	12	11	11	10	9	8	8	7	7	6	6	6	6	5	5	4	4	3	3	2	2
55	16	15	14	13	12	12	10	10	9	9	8	8	7	7	6	6	5	5	4	4	4	4	3	3
56	16	15	14	13	13	12	11	11	10	10	9	8	8	8	7	7	6	6	5	5	4	4	3	3
57	17	16	15	14	13	13	12	11	10	10	9	8	8	8	7	7	6	6	5	5	5	4	4	4
58	18	17	16	15	14	14	13	12	11	11	10	9	9	9	8	8	7	7	6	6	5	5	4	4
59	19	18	17	16	15	14	13	13	12	11	10	9	9	9	8	8	7	7	6	6	5	5	5	4
60	19	18	17	17	16	15	14	13	12	12	11	10	10	10	9	9	8	8	7	7	6	6	5	5
61	20	19	18	17	16	15	14	14	13	13	12	11	10	10	9	9	8	8	7	7	6	6	6	5
62	21	20	19	18	17	16	15	14	13	13	12	11	11	11	10	10	9	9	8	8	7	7	6	6
64	22	21	20	19	18	17	16	15	14	14	13	12	12	11	11	10	9	9	8	8	7	7	6	6
66	23	22	21	20	19	18	17	16	15	14	14	13	13	12	11	11	10	10	9	9	8	8	7	6
68	24	23	22	21	20	19	18	17	16	15	15	14	13	12	12	11	11	10	10	9	8	8	8	7
70	25	24	23	22	21	20	19	18	17	16	15	15	14	13	13	12	11	11	10	9	9	9	8	7
72	26	25	24	23	22	21	19	19	18	17	16	16	15	14	13	13	12	11	11	10	10	9	9	8
74	27	26	25	24	23	22	20	19	18	17	17	16	16	15	14	13	12	12	11	11	10	9	9	8
76	28	27	25	24	23	22	21	20	19	18	17	17	16	15	14	14	13	12	12	11	10	10	9	8
78	28	27	26	25	24	23	21	21	20	19	18	17	16	16	15	14	13	13	12	12	11	10	10	9
80	29	28	26	25	24	23	22	21	20	19	18	18	17	16	15	15	14	13	13	12	11	10	10	9
85	30	29	28	26	25	24	23	22	21	20	19	18	18	17	16	15	15	14	14	13	12	11	11	10
90	30	29	28	27	26	25	24	23	21	21	20	19	18	17	16	16	15	14	14	13	13	11	11	10

Greater App. Alt.	The Less Apparent Altitude.																							
	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°	52°	53°	54°	55°	56°	58°	60°	65°	70°	75°	80°	85°	90°
41°	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	..
50	1	1	0	0	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…	…	…	…	…
54	2	2	1	1	1	0	0	0	0	0	0	0	0	0	…	…	…	…	…	…	…	…	…	…
56	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	…	…	…	…	…	…	…	…
58	4	3	3	2	2	1	1	1	0	1	1	0	0	0	0	0	0	…	…	…	…	…	…	…
60	5	4	3	3	2	2	2	1	1	1	1	1	1	0	0	0	0	0	…	…	…	…	…	…
62	6	5	4	3	3	2	2	2	1	1	1	1	1	1	0	0	0	0	…	…	…	…	…	…
64	6	5	5	4	3	3	2	2	2	2	1	1	1	1	1	0	0	0	…	…	…	…	…	…
66	6	5	5	4	4	3	3	2	2	2	2	1	1	1	1	1	0	0	0	…	…	…	…	…
68	7	6	5	5	4	3	3	2	2	2	2	2	1	1	1	1	1	0	0	…	…	…	…	…
70	7	6	6	5	4	4	3	3	2	2	2	2	2	1	1	1	1	0	0	0	…	…	…	…
75	8	7	7	6	5	4	4	3	3	3	3	3	2	2	2	1	1	1	0	0	0	…	…	…
80	9	8	8	7	6	5	5	4	4	4	3	3	3	2	2	2	1	1	0	0	0	0	…	…
85	10	9	8	8	7	6	5	5	4	4	4	3	3	3	2	2	2	1	1	0	0	0	0	…
90	10	9	8	8	7	6	6.	5	4	4	4	3	3	3	2	2	2	1	1	0	0	0	0	0

TABLE VI.

First Correction to be added to the Apparent Distance.

Aux. Arc. Table V.	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°
″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
0	0 40	0 41	0 42	0 43	0 44	0 45	0 46	0 47	0 48	0 50	0 51	0 52	0 53	0 54	0 55	0 56	0 57
1	0 43	0 44	0 45	0 46	0 47	0 48	0 49	0 50	0 51	0 52	0 53	0 54	0 55	0 56	0 57	0 58	0 59
2	0 46	0 47	0 48	0 48	0 49	0 50	0 51	0 52	0 53	0 54	0 55	0 56	0 57	0 58	0 59	0 59	1 0
3	0 49	0 49	0 50	0 51	0 52	0 52	0 53	0 54	0 55	0 56	0 57	0 57	0 58	0 59	1 0	1 1	1 2
4	0 52	0 52	0 53	0 53	0 54	0 55	0 55	0 56	0 57	0 58	0 59	0 59	1 0	1 1	1 2	1 3	1 4
5	0 55	0 55	0 56	0 56	0 57	0 57	0 58	0 58	0 59	1 0	1 1	1 1	1 2	1 3	1 4	1 5	1 6
6	0 58	0 58	0 58	0 59	0 59	1 0	1 0	1 1	1 1	1 2	1 3	1 3	1 4	1 5	1 6	1 6	1 7
7	1 1	1 1	1 1	1 1	1 1	1 2	1 2	1 3	1 3	1 4	1 5	1 5	1 6	1 7	1 7	1 8	1 9
8	1 4	1 4	1 4	1 4	1 4	1 5	1 5	1 5	1 5	1 6	1 7	1 7	1 8	1 8	1 9	1 10	1 11
9	1 6	1 6	1 6	1 6	1 6	1 7	1 7	1 7	1 8	1 8	1 9	1 9	1 10	1 10	1 11	1 12	1 12
10	1 9	1 9	1 9	1 9	1 9	1 9	1 9	1 9	1 10	1 10	1 11	1 11	1 12	1 12	1 13	1 13	1 14
11	1 12	1 12	1 12	1 11	1 11	1 11	1 11	1 12	1 12	1 12	1 13	1 13	1 13	1 14	1 15	1 15	1 16
12	1 15	1 15	1 14	1 14	1 14	1 14	1 14	1 14	1 14	1 15	1 15	1 15	1 15	1 16	1 16	1 17	1 17
13	1 18	1 17	1 17	1 17	1 16	1 16	1 16	1 16	1 16	1 16	1 17	1 17	1 17	1 18	1 18	1 19	1 19
14	1 21	1 20	1 20	1 19	1 19	1 19	1 18	1 18	1 18	1 18	1 19	1 19	1 19	1 20	1 20	1 20	1 21
15	1 24	1 23	1 22	1 22	1 21	1 21	1 21	1 20	1 20	1 20	1 21	1 21	1 21	1 21	1 22	1 22	1 23
16	1 27	1 26	1 25	1 24	1 24	1 23	1 23	1 23	1 22	1 22	1 23	1 23	1 23	1 23	1 24	1 24	1 24
17	1 30	1 29	1 28	1 27	1 26	1 26	1 25	1 25	1 25	1 25	1 25	1 25	1 25	1 25	1 25	1 26	1 26
18	1 33	1 31	1 30	1 29	1 29	1 28	1 27	1 27	1 27	1 27	1 27	1 27	1 27	1 27	1 27	1 27	1 28
19	1 36	1 34	1 33	1 32	1 31	1 30	1 30	1 29	1 29	1 29	1 29	1 29	1 29	1 29	1 29	1 29	1 29
20	1 39	1 37	1 36	1 34	1 33	1 33	1 32	1 31	1 31	1 31	1 31	1 30	1 30	1 31	1 31	1 31	1 31
21	1 41	1 40	1 38	1 37	1 36	1 35	1 34	1 34	1 33	1 33	1 33	1 32	1 32	1 32	1 32	1 33	1 33
22	1 44	1 43	1 41	1 40	1 38	1 37	1 36	1 36	1 35	1 35	1 35	1 34	1 34	1 34	1 34	1 34	1 34
23	1 47	1 45	1 44	1 42	1 41	1 40	1 39	1 38	1 37	1 37	1 37	1 36	1 36	1 36	1 36	1 36	1 36
24	1 50	1 48	1 46	1 45	1 43	1 42	1 41	1 40	1 40	1 39	1 39	1 38	1 38	1 38	1 38	1 38	1 38
25	1 53	1 51	1 49	1 47	1 46	1 45	1 44	1 43	1 42	1 41	1 41	1 40	1 40	1 40	1 40	1 40	1 40
26	1 56	1 54	1 52	1 50	1 48	1 47	1 46	1 45	1 44	1 43	1 43	1 42	1 42	1 42	1 41	1 41	1 41
27	1 59	1 56	1 54	1 52	1 51	1 49	1 48	1 47	1 46	1 45	1 45	1 44	1 44	1 43	1 43	1 43	1 43
28	2 2	1 59	1 57	1 55	1 53	1 52	1 50	1 49	1 48	1 47	1 47	1 46	1 46	1 45	1 45	1 45	1 45
29	2 5	2 2	2 0	1 58	1 56	1 54	1 53	1 51	1 50	1 49	1 49	1 48	1 47	1 47	1 47	1 47	1 46
30	2 8	2 5	2 2	2 0	1 58	1 56	1 55	1 54	1 52	1 51	1 51	1 50	1 49	1 49	1 49	1 48	1 48
31	2 11	2 8	2 5	2 3	2 1	1 59	1 57	1 56	1 55	1 54	1 53	1 52	1 51	1 51	1 50	1 50	1 50
32	2 14	2 11	2 8	2 5	2 3	2 1	1 59	1 58	1 57	1 56	1 55	1 54	1 53	1 53	1 52	1 52	1 51
33	2 17	2 13	2 10	2 7	2 5	2 3	2 2	2 0	1 59	1 58	1 57	1 56	1 55	1 54	1 54	1 54	1 53
34	2 20	2 16	2 13	2 10	2 8	2 6	2 4	2 2	2 1	2 0	1 59	1 58	1 57	1 56	1 56	1 55	1 55
35	2 22	2 19	2 16	2 13	2 10	2 8	2 6	2 5	2 3	2 2	2 1	2 0	1 59	1 58	1 57	1 57	1 57
36	2 25	2 22	2 18	2 15	2 13	2 10	2 8	2 7	2 5	2 4	2 3	2 2	2 1	2 0	1 59	1 59	1 58
37	2 28	2 24	2 21	2 18	2 15	2 13	2 11	2 9	2 7	2 6	2 5	2 4	2 3	2 2	2 1	2 1	2 0
38	2 31	2 27	2 24	2 21	2 18	2 15	2 13	2 11	2 9	2 8	2 7	2 5	2 4	2 4	2 3	2 2	2 2
39	2 34	2 30	2 26	2 23	2 20	2 17	2 15	2 13	2 12	2 10	2 9	2 7	2 6	2 5	2 5	2 4	2 3
40	2 37	2 33	2 29	2 26	2 23	2 20	2 18	2 16	2 14	2 12	2 11	2 9	2 8	2 7	2 6	2 6	2 5
41	2 40	2 36	2 32	2 28	2 25	2 22	2 20	2 18	2 16	2 14	2 13	2 11	2 10	2 9	2 8	2 7	2 7
42	2 43	2 38	2 34	2 31	2 28	2 25	2 22	2 20	2 18	2 16	2 15	2 13	2 12	2 11	2 10	2 9	2 9
43	2 46	2 41	2 37	2 33	2 30	2 27	2 24	2 22	2 20	2 18	2 17	2 15	2 14	2 13	2 12	2 11	2 10
44	2 49	2 44	2 40	2 36	2 32	2 29	2 27	2 24	2 22	2 20	2 19	2 17	2 16	2 15	2 14	2 13	2 12
45	2 52	2 47	2 42	2 38	2 35	2 32	2 29	2 27	2 24	2 22	2 21	2 19	2 18	2 16	2 15	2 14	2 14
46	2 55	2 50	2 45	2 41	2 37	2 34	2 31	2 29	2 26	2 24	2 23	2 21	2 20	2 18	2 17	2 16	2 15
47	2 57	2 52	2 48	2 44	2 40	2 37	2 34	2 31	2 29	2 27	2 25	2 23	2 21	2 20	2 19	2 18	2 17
48	3 0	2 55	2 50	2 46	2 42	2 39	2 36	2 33	2 31	2 29	2 27	2 25	2 23	2 22	2 21	2 20	2 19
49	3 3	2 58	2 53	2 49	2 45	2 41	2 38	2 35	2 33	2 31	2 29	2 27	2 25	2 24	2 23	2 21	2 20
50	3 6	3 1	2 56	2 51	2 47	2 43	2 40	2 37	2 35	2 33	2 31	2 29	2 27	2 25	2 24	2 23	2 22
50	2 26	2 20	2 14	2 8	2 3	1 58	1 54	1 50	1 47	1 43	1 40	1 37	1 34	1 31	1 29	1 27	1 25
60	2 55	2 47	2 40	2 34	2 28	2 22	2 17	2 12	2 8	2 4	2 0	1 56	1 53	1 50	1 47	1 45	1 42
70	3 24	3 15	3 7	2 59	2 52	2 46	2 40	2 34	2 29	2 24	2 20	2 16	2 12	2 9	2 5	2 2	1 59
80	3 53	3 43	3 34	3 25	3 17	3 9	3 2	2 56	2 50	2 45	2 40	2 35	2 31	2 27	2 23	2 20	2 16
90	4 23	4 11	4 0	3 50	3 41	3 33	3 25	3 18	3 12	3 6	3 0	2 55	2 50	2 45	2 41	2 37	2 33
100	4 52	4 39	4 27	4 16	4 6	3 57	3 48	3 40	3 33	3 26	3 20	3 14	3 9	3 4	2 59	2 54	2 50
150	7 18	6 59	6 41	6 24	6 9	5 55	5 42	5 30	5 19	5 9	5 0	4 51	4 43	4 35	4 28	4 21	4 15
200	9 44	9 18	8 54	8 32	8 12	7 53	7 36	7 20	7 6	6 53	6 40	6 28	6 17	6 7	5 58	5 49	5 40
250	12 11	11 38	11 8	10 40	10 15	9 52	9 31	9 11	8 53	8 36	8 20	8 5	7 52	7 39	7 27	7 16	7 6
300	14 37	13 57	13 21	12 48	12 18	11 50	11 25	11 2	10 40	10 19	10 0	9 42	9 25	9 10	8 56	8 43	8 31

TABLE VI.

First Correction to be added to the Apparent Distance.

Aux. Arc. Table V.	37°	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°	52°	53°
″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
0	0 58	0 59	1 0	1 2	1 3	1 4	1 5	1 6	1 7	1 8	1 10	1 11	1 12	1 13	1 14	1 16	1 17
1	1 0	1 1	1 2	1 3	1 4	1 5	1 6	1 8	1 9	1 10	1 11	1 12	1 13	1 15	1 16	1 17	1 18
2	1 2	1 3	1 4	1 5	1 6	1 7	1 8	1 9	1 10	1 11	1 12	1 14	1 15	1 16	1 17	1 18	1 19
3	1 3	1 4	1 5	1 6	1 7	1 8	1 9	1 10	1 12	1 13	1 14	1 15	1 16	1 17	1 18	1 19	1 21
4	1 5	1 6	1 7	1 8	1 9	1 10	1 11	1 12	1 13	1 14	1 15	1 16	1 17	1 18	1 20	1 21	1 22
5	1 6	1 7	1 8	1 9	1 10	1 11	1 12	1 13	1 14	1 15	1 16	1 18	1 19	1 20	1 21	1 22	1 23
6	1 8	1 9	1 10	1 11	1 12	1 13	1 14	1 15	1 16	1 17	1 18	1 19	1 20	1 21	1 22	1 23	1 24
7	1 10	1 11	1 12	1 12	1 13	1 14	1 15	1 16	1 17	1 18	1 19	1 20	1 21	1 22	1 23	1 25	1 26
8	1 11	1 12	1 13	1 14	1 15	1 16	1 17	1 18	1 19	1 20	1 21	1 22	1 23	1 24	1 25	1 26	1 27
9	1 13	1 14	1 15	1 16	1 16	1 17	1 18	1 19	1 20	1 21	1 22	1 23	1 24	1 25	1 26	1 27	1 28
10	1 15	1 16	1 16	1 17	1 18	1 19	1 20	1 20	1 21	1 22	1 23	1 24	1 25	1 26	1 27	1 28	1 29
11	1 16	1 17	1 18	1 19	1 19	1 20	1 21	1 22	1 23	1 24	1 25	1 26	1 27	1 28	1 29	1 30	1 31
12	1 18	1 19	1 20	1 20	1 21	1 22	1 23	1 23	1 24	1 25	1 26	1 27	1 28	1 29	1 30	1 31	1 32
13	1 20	1 20	1 21	1 22	1 23	1 23	1 24	1 25	1 26	1 27	1 27	1 28	1 29	1 30	1 31	1 32	1 33
14	1 21	1 22	1 23	1 23	1 24	1 25	1 26	1 26	1 27	1 28	1 29	1 30	1 31	1 32	1 33	1 33	1 34
15	1 23	1 24	1 24	1 25	1 26	1 26	1 27	1 28	1 29	1 29	1 30	1 31	1 32	1 33	1 34	1 35	1 36
16	1 25	1 25	1 26	1 26	1 27	1 28	1 28	1 29	1 30	1 31	1 32	1 32	1 33	1 34	1 35	1 36	1 37
17	1 26	1 27	1 27	1 28	1 29	1 29	1 30	1 31	1 31	1 32	1 33	1 34	1 35	1 35	1 36	1 37	1 38
18	1 28	1 29	1 29	1 30	1 30	1 31	1 31	1 32	1 33	1 33	1 34	1 35	1 36	1 37	1 38	1 38	1 39
19	1 30	1 30	1 31	1 31	1 32	1 32	1 33	1 34	1 34	1 35	1 36	1 36	1 37	1 38	1 39	1 40	1 41
20	1 31	1 32	1 32	1 33	1 33	1 34	1 34	1 35	1 36	1 36	1 37	1 38	1 39	1 39	1 40	1 41	1 42
21	1 33	1 33	1 34	1 34	1 35	1 35	1 36	1 36	1 37	1 38	1 38	1 39	1 40	1 41	1 41	1 42	1 43
22	1 35	1 35	1 35	1 36	1 36	1 37	1 37	1 38	1 38	1 39	1 40	1 40	1 41	1 42	1 43	1 44	1 44
23	1 36	1 37	1 37	1 37	1 38	1 38	1 39	1 39	1 40	1 40	1 41	1 42	1 43	1 43	1 44	1 45	1 46
24	1 38	1 38	1 39	1 39	1 39	1 40	1 40	1 41	1 41	1 42	1 43	1 43	1 44	1 45	1 45	1 46	1 47
25	1 40	1 40	1 40	1 41	1 41	1 41	1 42	1 42	1 43	1 43	1 44	1 45	1 45	1 46	1 47	1 47	1 48
26	1 41	1 42	1 42	1 42	1 42	1 43	1 43	1 44	1 44	1 45	1 45	1 46	1 47	1 47	1 48	1 49	1 49
27	1 43	1 43	1 43	1 44	1 44	1 44	1 45	1 45	1 45	1 46	1 47	1 47	1 48	1 49	1 49	1 50	1 51
28	1 45	1 45	1 45	1 45	1 45	1 46	1 46	1 46	1 47	1 47	1 48	1 49	1 49	1 50	1 51	1 51	1 52
29	1 46	1 46	1 47	1 47	1 47	1 47	1 47	1 48	1 48	1 49	1 49	1 50	1 50	1 51	1 52	1 53	1 53
30	1 48	1 48	1 48	1 48	1 48	1 49	1 49	1 49	1 50	1 50	1 51	1 51	1 52	1 52	1 53	1 54	1 54
31	1 50	1 50	1 50	1 50	1 50	1 50	1 50	1 51	1 51	1 52	1 52	1 53	1 53	1 54	1 54	1 55	1 56
32	1 51	1 51	1 51	1 51	1 51	1 52	1 52	1 52	1 52	1 53	1 53	1 54	1 54	1 55	1 56	1 56	1 57
33	1 53	1 53	1 53	1 53	1 53	1 53	1 53	1 54	1 54	1 54	1 55	1 55	1 56	1 56	1 57	1 58	1 58
34	1 55	1 55	1 54	1 54	1 54	1 55	1 55	1 55	1 55	1 56	1 56	1 57	1 57	1 58	1 58	1 59	1 59
35	1 56	1 56	1 56	1 56	1 56	1 56	1 56	1 56	1 57	1 57	1 58	1 58	1 58	1 59	1 59	2 0	2 1
36	1 58	1 58	1 58	1 58	1 58	1 58	1 58	1 58	1 58	1 58	1 59	1 59	2 0	2 0	2 1	2 1	2 2
37	2 0	1 59	1 59	1 59	1 59	1 59	1 59	1 59	2 0	2 0	2 0	2 1	2 1	2 2	2 2	2 3	2 3
38	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 2	2 2	2 2	2 3	2 3	2 3	2 4	2 4
39	2 3	2 3	2 2	2 2	2 2	2 2	2 2	2 2	2 2	2 3	2 3	2 3	2 4	2 4	2 5	2 5	2 6
40	2 5	2 4	2 4	2 4	2 4	2 4	2 4	2 4	2 4	2 4	2 4	2 5	2 5	2 5	2 6	2 6	2 7
41	2 6	2 6	2 6	2 5	2 5	2 5	2 5	2 5	2 5	2 5	2 6	2 6	2 6	2 7	2 7	2 8	2 8
42	2 8	2 8	2 8	2 7	2 7	2 7	2 7	2 7	2 7	2 7	2 7	2 8	2 8	2 8	2 8	2 9	2 9
43	2 10	2 9	2 9	2 8	2 8	2 8	2 8	2 8	2 8	2 8	2 8	2 9	2 9	2 9	2 10	2 10	2 11
44	2 11	2 11	2 10	2 10	2 10	2 10	2 9	2 9	2 9	2 10	2 10	2 10	2 10	2 11	2 11	2 12	2 12
45	2 13	2 12	2 12	2 12	2 11	2 11	2 11	2 11	2 11	2 11	2 11	2 11	2 12	2 12	2 12	2 13	2 13
46	2 15	2 14	2 14	2 13	2 13	2 13	2 12	2 12	2 12	2 12	2 13	2 13	2 13	2 13	2 14	2 14	2 14
47	2 16	2 16	2 15	2 15	2 14	2 14	2 14	2 14	2 14	2 14	2 14	2 14	2 14	2 15	2 15	2 15	2 16
48	2 18	2 17	2 16	2 16	2 16	2 16	2 15	2 15	2 15	2 15	2 15	2 15	2 16	2 16	2 16	2 17	2 17
49	2 20	2 19	2 18	2 18	2 17	2 17	2 17	2 17	2 17	2 17	2 17	2 17	2 17	2 17	2 17	2 18	2 18
50	2 21	2 20	2 20	2 19	2 19	2 19	2 18	2 18	2 18	2 18	2 18	2 18	2 18	2 18	2 19	2 19	2 19
50	1 23	1 21	1 19	1 18	1 16	1 15	1 13	1 12	1 11	1 10	1 8	1 7	1 6	1 5	1 4	1 3	1 3
60	1 40	1 37	1 35	1 33	1 32	1 30	1 28	1 26	1 25	1 23	1 22	1 21	1 20	1 18	1 17	1 16	1 15
70	1 56	1 54	1 51	1 49	1 47	1 45	1 43	1 41	1 39	1 37	1 36	1 34	1 33	1 31	1 30	1 29	1 28
80	2 13	2 10	2 7	2 4	2 2	2 0	1 57	1 55	1 53	1 51	1 49	1 48	1 46	1 44	1 43	1 42	1 40
90	2 30	2 26	2 23	2 20	2 17	2 15	2 12	2 10	2 7	2 5	2 3	2 1	1 59	1 58	1 56	1 54	1 53
100	2 46	2 42	2 39	2 36	2 32	2 29	2 27	2 24	2 21	2 19	2 17	2 15	2 13	2 11	2 9	2 7	2 5
150	4 9	4 4	3 58	3 53	3 49	3 44	3 40	3 36	3 32	3 29	3 25	3 22	3 19	3 16	3 13	3 10	3 8
200	5 32	5 25	5 18	5 11	5 5	4 59	4 53	4 48	4 43	4 38	4 33	4 29	4 25	4 21	4 17	4 14	4 10
250	6 55	6 46	6 37	6 29	6 21	6 14	6 7	6 0	5 53	5 47	5 42	5 37	5 31	5 26	5 22	5 17	5 13
300	8 18	8 7	7 57	7 47	7 37	7 28	7 20	7 12	7 4	6 57	6 50	6 44	6 38	6 32	6 26	6 21	6 16

TABLE VI.

First Correction to be added to the Apparent Distance.

Aux. Arc. Table V.	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	70°
″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
0	1 18	1 19	1 21	1 22	1 23	1 25	1 26	1 27	1 29	1 30	1 31	1 33	1 34	1 36	1 37	1 38	1 40
1	1 19	1 21	1 22	1 23	1 24	1 26	1 27	1 28	1 30	1 31	1 32	1 34	1 35	1 37	1 38	1 39	1 41
2	1 21	1 22	1 23	1 24	1 26	1 27	1 28	1 30	1 31	1 32	1 34	1 35	1 36	1 38	1 39	1 41	1 42
3	1 22	1 23	1 24	1 26	1 27	1 28	1 29	1 31	1 32	1 33	1 35	1 36	1 37	1 39	1 40	1 42	1 43
4	1 23	1 24	1 25	1 27	1 28	1 29	1 30	1 32	1 33	1 34	1 36	1 37	1 38	1 40	1 41	1 43	1 44
5	1 24	1 26	1 27	1 28	1 29	1 30	1 32	1 33	1 34	1 36	1 37	1 38	1 40	1 41	1 42	1 44	1 45
6	1 26	1 27	1 28	1 29	1 30	1 32	1 33	1 34	1 35	1 37	1 38	1 39	1 41	1 42	1 43	1 45	1 46
7	1 27	1 28	1 29	1 30	1 32	1 33	1 34	1 35	1 36	1 38	1 39	1 40	1 42	1 43	1 45	1 46	1 47
8	1 28	1 29	1 30	1 32	1 33	1 34	1 35	1 36	1 38	1 39	1 40	1 41	1 43	1 44	1 46	1 47	1 48
9	1 29	1 30	1 32	1 33	1 34	1 35	1 36	1 37	1 39	1 40	1 41	1 43	1 44	1 45	1 47	1 48	1 49
10	1 30	1 32	1 33	1 34	1 35	1 36	1 37	1 39	1 40	1 41	1 42	1 44	1 45	1 46	1 48	1 49	1 50
11	1 32	1 33	1 34	1 35	1 36	1 37	1 39	1 40	1 41	1 42	1 44	1 45	1 46	1 48	1 49	1 50	1 52
12	1 33	1 34	1 35	1 36	1 37	1 39	1 40	1 41	1 42	1 43	1 45	1 46	1 47	1 49	1 50	1 51	1 53
13	1 34	1 35	1 36	1 37	1 39	1 40	1 41	1 42	1 43	1 44	1 46	1 47	1 48	1 50	1 51	1 52	1 54
14	1 35	1 36	1 38	1 39	1 40	1 41	1 42	1 43	1 44	1 46	1 47	1 48	1 49	1 51	1 52	1 53	1 55
15	1 37	1 38	1 39	1 40	1 41	1 42	1 43	1 44	1 46	1 47	1 48	1 49	1 51	1 52	1 53	1 54	1 56
16	1 38	1 39	1 40	1 41	1 42	1 43	1 44	1 46	1 47	1 48	1 49	1 50	1 52	1 53	1 54	1 56	1 57
17	1 39	1 40	1 41	1 42	1 43	1 44	1 46	1 47	1 48	1 49	1 50	1 51	1 53	1 54	1 55	1 57	1 58
18	1 40	1 41	1 42	1 43	1 44	1 46	1 47	1 48	1 49	1 50	1 51	1 53	1 54	1 55	1 56	1 58	1 59
19	1 42	1 43	1 44	1 45	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 54	1 55	1 56	1 57	1 59	2 0
20	1 43	1 44	1 45	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 54	1 55	1 56	1 57	1 59	2 0	2 1
21	1 44	1 45	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 53	1 55	1 56	1 57	1 58	2 0	2 1	2 2
22	1 45	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 53	1 55	1 56	1 57	1 58	1 59	2 1	2 2	2 3
23	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 54	1 55	1 56	1 57	1 58	1 59	2 1	2 2	2 3	2 4
24	1 48	1 49	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 2	2 3	2 4	2 5
25	1 49	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 2	2 3	2 4	2 5	2 6
26	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	2 3	2 4	2 5	2 6	2 8
27	1 51	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	2 3	2 4	2 5	2 6	2 7	2 9
28	1 53	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	2 2	2 4	2 5	2 6	2 7	2 8	2 10
29	1 54	1 55	1 56	1 57	1 57	1 58	1 59	2 0	2 1	2 2	2 4	2 5	2 6	2 7	2 8	2 9	2 11
30	1 55	1 56	1 57	1 58	1 59	2 0	2 1	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 11	2 12
31	1 56	1 57	1 58	1 59	2 0	2 1	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 12	2 13
32	1 58	1 58	1 59	2 0	2 1	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 13	2 14
33	1 59	2 0	2 0	2 1	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	2 14	2 15
34	2 0	2 1	2 2	2 3	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	2 14	2 15	2 16
35	2 1	2 2	2 3	2 4	2 5	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	2 14	2 15	2 16	2 17
36	2 3	2 3	2 4	2 5	2 6	2 7	2 7	2 8	2 9	2 10	2 11	2 12	2 14	2 15	2 16	2 17	2 18
37	2 4	2 5	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	2 14	2 15	2 16	2 17	2 18	2 19	
38	2 5	2 6	2 7	2 7	2 8	2 9	2 10	2 11	2 12	2 13	2 14	2 15	2 16	2 17	2 18	2 19	2 20
39	2 6	2 7	2 8	2 8	2 9	2 10	2 11	2 12	2 13	2 14	2 15	2 16	2 17	2 18	2 19	2 20	2 21
40	2 8	2 8	2 9	2 10	2 10	2 11	2 12	2 13	2 14	2 15	2 16	2 17	2 18	2 19	2 20	2 21	2 22
41	2 9	2 9	2 10	2 11	2 12	2 12	2 13	2 14	2 15	2 16	2 17	2 18	2 19	2 20	2 21	2 22	2 23
42	2 10	2 11	2 11	2 12	2 13	2 14	2 14	2 15	2 16	2 17	2 18	2 19	2 20	2 21	2 22	2 23	2 25
43	2 11	2 12	2 13	2 13	2 14	2 15	2 15	2 16	2 17	2 18	2 19	2 20	2 21	2 22	2 23	2 24	2 26
44	2 13	2 13	2 14	2 14	2 15	2 16	2 17	2 18	2 18	2 19	2 20	2 21	2 22	2 23	2 24	2 25	2 27
45	2 14	2 14	2 15	2 16	2 16	2 17	2 18	2 19	2 20	2 20	2 21	2 22	2 23	2 24	2 25	2 27	2 28
46	2 15	2 16	2 16	2 17	2 18	2 18	2 19	2 20	2 21	2 22	2 23	2 24	2 25	2 26	2 27	2 28	2 29
47	2 16	2 17	2 17	2 18	2 19	2 19	2 20	2 21	2 22	2 23	2 24	2 25	2 26	2 27	2 28	2 29	2 30
48	2 17	2 18	2 19	2 19	2 20	2 21	2 21	2 22	2 23	2 24	2 25	2 26	2 27	2 28	2 29	2 30	2 31
49	2 19	2 19	2 20	2 20	2 21	2 22	2 22	2 23	2 24	2 25	2 26	2 27	2 28	2 29	2 30	2 31	2 32
50	2 20	2 20	2 21	2 22	2 22	2 23	2 24	2 24	2 25	2 26	2 27	2 28	2 29	2 30	2 31	2 32	2 33
50	1 2	1 1	1 0	1 0	0 59	0 58	0 58	0 57	0 57	0 56	0 56	0 55	0 55	0 54	0 54	0 54	0 53
60	1 14	1 13	1 12	1 12	1 11	1 10	1 9	1 9	1 8	1 7	1 7	1 6	1 6	1 5	1 5	1 4	1 4
70	1 27	1 25	1 24	1 23	1 23	1 22	1 21	1 20	1 19	1 19	1 18	1 17	1 17	1 16	1 15	1 15	1 14
80	1 39	1 38	1 36	1 35	1 34	1 33	1 32	1 31	1 30	1 29	1 28	1 28	1 27	1 26	1 26	1 25	
90	1 51	1 50	1 49	1 47	1 46	1 45	1 44	1 43	1 42	1 41	1 40	1 39	1 38	1 38	1 37	1 36	1 36
100	2 4	2 2	2 1	1 59	1 58	1 57	1 55	1 54	1 53	1 52	1 51	1 50	1 49	1 49	1 48	1 47	1 46
150	3 5	3 3	3 1	2 59	2 57	2 55	2 53	2 52	2 50	2 48	2 47	2 45	2 44	2 43	2 42	2 41	2 40
200	4 7	4 4	4 1	3 58	3 56	3 53	3 51	3 49	3 46	3 44	3 42	3 41	3 39	3 37	3 36	3 34	3 33
250	5 9	5 5	5 2	4 58	4 55	4 52	4 49	4 46	4 43	4 41	4 38	4 36	4 34	4 32	4 30	4 28	4 26
300	6 11	6 6	6 2	5 58	5 54	5 50	5 46	5 43	5 40	5 37	5 34	5 31	5 28	5 26	5 24	5 21	5 19

TABLE VI.

First Correction to be added to the Apparent Distance.

Aux. Arc. Table V.	71°	72°	73°	74°	75°	76°	77°	78°	79°	80°	81°	82°	83°	84°	85°	86°	87°
	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
0	1 41	1 43	1 44	1 46	1 48	1 49	1 51	1 52	1 54	1 56	1 57	1 59	2 1	2 3	2 5	2 6	2 8
1	1 42	1 44	1 45	1 47	1 49	1 50	1 52	1 53	1 55	1 57	1 58	2 0	2 2	2 4	2 6	2 7	2 9
2	1 43	1 45	1 47	1 48	1 50	1 51	1 53	1 54	1 56	1 58	1 59	2 1	2 3	2 5	2 7	2 8	2 10
3	1 45	1 46	1 48	1 49	1 51	1 52	1 54	1 55	1 57	1 59	2 0	2 2	2 4	2 6	2 8	2 9	2 11
4	1 46	1 47	1 49	1 50	1 52	1 53	1 55	1 56	1 58	2 0	2 2	2 3	2 5	2 7	2 9	2 10	2 12
5	1 47	1 48	1 50	1 51	1 53	1 54	1 56	1 57	1 59	2 1	2 3	2 4	2 6	2 8	2 10	2 11	2 13
6	1 48	1 49	1 51	1 52	1 54	1 55	1 57	1 58	2 0	2 2	2 4	2 5	2 7	2 9	2 11	2 12	2 14
7	1 49	1 50	1 52	1 53	1 55	1 56	1 58	1 59	2 1	2 3	2 5	2 6	2 8	2 10	2 12	2 13	2 15
8	1 50	1 51	1 53	1 54	1 56	1 57	1 59	2 1	2 2	2 4	2 6	2 7	2 9	2 11	2 13	2 14	2 16
9	1 51	1 52	1 54	1 55	1 57	1 58	2 0	2 2	2 3	2 5	2 7	2 8	2 10	2 12	2 14	2 15	2 17
10	1 52	1 53	1 55	1 56	1 58	1 59	2 1	2 3	2 4	2 6	2 8	2 9	2 11	2 13	2 15	2 16	2 18
11	1 53	1 54	1 56	1 57	1 59	2 0	2 2	2 4	2 5	2 7	2 9	2 10	2 12	2 14	2 16	2 17	2 19
12	1 54	1 56	1 57	1 59	2 0	2 2	2 3	2 5	2 6	2 8	2 10	2 11	2 13	2 15	2 17	2 18	2 20
13	1 55	1 57	1 58	2 0	2 1	2 3	2 4	2 6	2 7	2 9	2 11	2 12	2 14	2 16	2 18	2 19	2 21
14	1 56	1 58	1 59	2 1	2 2	2 4	2 5	2 7	2 8	2 10	2 12	2 13	2 15	2 17	2 19	2 20	2 22
15	1 57	1 59	2 0	2 2	2 3	2 5	2 6	2 8	2 9	2 11	2 13	2 14	2 16	2 18	2 20	2 21	2 23
16	1 58	2 0	2 1	2 3	2 4	2 6	2 7	2 9	2 10	2 12	2 14	2 15	2 17	2 19	2 21	2 22	2 24
17	1 59	2 1	2 2	2 4	2 5	2 7	2 8	2 10	2 11	2 13	2 15	2 16	2 18	2 20	2 22	2 23	2 25
18	2 0	2 2	2 3	2 5	2 6	2 8	2 9	2 11	2 12	2 14	2 16	2 17	2 19	2 21	2 23	2 24	2 26
19	2 1	2 3	2 4	2 6	2 7	2 9	2 10	2 12	2 13	2 15	2 17	2 18	2 20	2 22	2 24	2 25	2 27
20	2 3	2 4	2 5	2 7	2 8	2 10	2 11	2 13	2 14	2 16	2 18	2 19	2 21	2 23	2 25	2 26	2 28
21	2 4	2 5	2 6	2 8	2 9	2 11	2 12	2 14	2 15	2 17	2 19	2 20	2 22	2 24	2 26	2 27	2 29
22	2 5	2 6	2 7	2 9	2 10	2 12	2 13	2 15	2 16	2 18	2 20	2 21	2 23	2 25	2 27	2 28	2 30
23	2 6	2 7	2 8	2 10	2 11	2 13	2 14	2 16	2 17	2 19	2 21	2 22	2 24	2 26	2 28	2 29	2 31
24	2 7	2 8	2 10	2 11	2 12	2 14	2 15	2 17	2 19	2 20	2 22	2 23	2 25	2 27	2 29	2 30	2 32
25	2 8	2 9	2 11	2 12	2 13	2 15	2 16	2 18	2 20	2 21	2 23	2 24	2 26	2 28	2 30	2 31	2 33
26	2 9	2 10	2 12	2 13	2 14	2 16	2 17	2 19	2 21	2 22	2 24	2 25	2 27	2 29	2 31	2 32	2 34
27	2 10	2 11	2 13	2 14	2 15	2 17	2 18	2 20	2 22	2 23	2 25	2 26	2 28	2 30	2 32	2 33	2 35
28	2 11	2 12	2 14	2 15	2 17	2 18	2 20	2 21	2 23	2 24	2 26	2 27	2 29	2 31	2 33	2 34	2 36
29	2 12	2 13	2 15	2 16	2 18	2 19	2 21	2 22	2 24	2 25	2 27	2 28	2 30	2 32	2 34	2 35	2 37
30	2 13	2 14	2 16	2 17	2 19	2 20	2 22	2 23	2 25	2 26	2 28	2 29	2 31	2 33	2 35	2 36	2 38
31	2 14	2 15	2 17	2 18	2 20	2 21	2 23	2 24	2 26	2 27	2 29	2 30	2 32	2 34	2 36	2 37	2 39
32	2 15	2 17	2 18	2 19	2 21	2 22	2 24	2 25	2 27	2 28	2 30	2 31	2 33	2 35	2 37	2 38	2 40
33	2 16	2 18	2 19	2 20	2 22	2 23	2 25	2 26	2 28	2 29	2 31	2 32	2 34	2 36	2 38	2 39	2 41
34	2 17	2 19	2 20	2 21	2 23	2 24	2 26	2 27	2 29	2 30	2 32	2 33	2 35	2 37	2 39	2 40	2 42
35	2 18	2 20	2 21	2 22	2 24	2 25	2 27	2 28	2 30	2 31	2 33	2 35	2 36	2 38	2 40	2 41	2 43
36	2 19	2 21	2 22	2 23	2 25	2 26	2 28	2 29	2 31	2 32	2 34	2 36	2 37	2 39	2 41	2 42	2 44
37	2 20	2 22	2 23	2 24	2 26	2 27	2 29	2 30	2 32	2 33	2 35	2 37	2 38	2 40	2 42	2 43	2 45
38	2 22	2 23	2 24	2 25	2 27	2 28	2 30	2 31	2 33	2 34	2 36	2 38	2 39	2 41	2 43	2 44	2 46
39	2 23	2 24	2 25	2 27	2 28	2 29	2 31	2 32	2 34	2 35	2 37	2 39	2 40	2 42	2 44	2 45	2 47
40	2 24	2 25	2 26	2 28	2 29	2 30	2 32	2 33	2 35	2 36	2 38	2 40	2 41	2 43	2 45	2 46	2 48
41	2 25	2 26	2 27	2 29	2 30	2 31	2 33	2 34	2 36	2 37	2 39	2 41	2 42	2 44	2 46	2 47	2 49
42	2 26	2 27	2 28	2 30	2 31	2 32	2 34	2 35	2 37	2 38	2 40	2 42	2 43	2 45	2 47	2 48	2 50
43	2 27	2 28	2 29	2 31	2 32	2 33	2 35	2 36	2 38	2 39	2 41	2 43	2 44	2 46	2 48	2 49	2 51
44	2 28	2 29	2 30	2 32	2 33	2 35	2 36	2 37	2 39	2 40	2 42	2 44	2 45	2 47	2 49	2 50	2 52
45	2 29	2 30	2 31	2 33	2 34	2 36	2 37	2 38	2 40	2 41	2 43	2 45	2 46	2 48	2 50	2 51	2 53
46	2 30	2 31	2 33	2 34	2 35	2 37	2 38	2 39	2 41	2 42	2 44	2 46	2 47	2 49	2 51	2 52	2 54
47	2 31	2 32	2 34	2 35	2 36	2 38	2 39	2 40	2 42	2 43	2 45	2 47	2 48	2 50	2 52	2 53	2 55
48	2 32	2 33	2 35	2 36	2 37	2 39	2 40	2 41	2 43	2 44	2 46	2 48	2 49	2 51	2 53	2 54	2 56
49	2 33	2 34	2 36	2 37	2 38	2 40	2 41	2 42	2 44	2 46	2 47	2 49	2 50	2 52	2 54	2 55	2 57
50	2 34	2 35	2 37	2 38	2 39	2 41	2 42	2 43	2 45	2 47	2 48	2 50	2 51	2 53	2 55	2 56	2 58
50	0 53	0 53	0 52	0 52	0 52	0 52	0 51	0 51	0 51	0 51	0 51	0 51	0 50	0 50	0 50	0 50	0 50
60	1 3	1 3	1 3	1 2	1 2	1 2	1 2	1 1	1 1	1 1	1 1	1 1	1 0	1 0	1 0	1 0	1 0
70	1 14	1 14	1 13	1 13	1 12	1 12	1 12	1 12	1 11	1 11	1 11	1 11	1 11	1 10	1 10	1 10	1 10
80	1 25	1 24	1 24	1 23	1 23	1 22	1 22	1 22	1 22	1 21	1 21	1 21	1 21	1 21	1 20	1 20	1 20
90	1 35	1 35	1 34	1 34	1 33	1 33	1 32	1 32	1 32	1 31	1 31	1 31	1 31	1 31	1 30	1 30	1 30
100	1 46	1 45	1 45	1 44	1 44	1 43	1 43	1 42	1 42	1 42	1 41	1 41	1 41	1 41	1 40	1 40	1 40
150	2 39	2 38	2 37	2 36	2 35	2 34	2 33	2 33	2 32	2 32	2 32	2 32	2 31	2 31	2 31	2 30	2 30
200	3 32	3 30	3 29	3 28	3 27	3 26	3 25	3 24	3 24	3 23	3 22	3 22	3 22	3 21	3 21	3 21	3 20
250	4 25	4 23	4 21	4 20	4 19	4 18	4 17	4 16	4 15	4 14	4 13	4 13	4 12	4 12	4 11	4 11	4 10
300	5 17	5 15	5 14	5 12	5 11	5 9	5 8	5 7	5 6	5 5	5 4	5 3	5 2	5 2	5 1	5 1	5 0

TABLE VI.

First Correction to be added to the Apparent Distance.

Aux. Arc. Table V	88°	89°	90°	91°	92°	93°	94°	95°	96°	97°	98°	99°	100°	101°	102°	103°	104°
″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
0	2 10	2 12	2 14	2 16	2 18	2 20	2 22	2 24	2 27	2 29	2 31	2 34	2 36	2 38	2 41	2 43	2 46
1	2 11	2 13	2 15	2 17	2 19	2 21	2 23	2 25	2 28	2 30	2 32	2 35	2 37	2 39	2 42	2 44	2 47
2	2 12	2 14	2 16	2 18	2 20	2 22	2 24	2 26	2 29	2 31	2 33	2 36	2 38	2 40	2 43	2 45	2 48
3	2 13	2 15	2 17	2 19	2 21	2 23	2 25	2 27	2 30	2 32	2 34	2 37	2 39	2 41	2 44	2 46	2 49
4	2 14	2 16	2 18	2 20	2 22	2 24	2 26	2 28	2 31	2 33	2 35	2 38	2 40	2 42	2 45	2 47	2 50
5	2 15	2 17	2 19	2 21	2 23	2 25	2 27	2 29	2 32	2 34	2 36	2 39	2 41	2 43	2 46	2 48	2 51
6	2 16	2 18	2 20	2 22	2 24	2 26	2 28	2 30	2 33	2 35	2 37	2 40	2 42	2 44	2 47	2 49	2 52
7	2 17	2 19	2 21	2 23	2 25	2 27	2 29	2 31	2 34	2 36	2 38	2 41	2 43	2 45	2 48	2 50	2 53
8	2 18	2 20	2 22	2 24	2 26	2 28	2 30	2 32	2 35	2 37	2 39	2 42	2 44	2 47	2 49	2 52	2 54
9	2 19	2 21	2 23	2 25	2 27	2 29	2 31	2 33	2 36	2 38	2 40	2 43	2 45	2 48	2 50	2 53	2 55
10	2 20	2 22	2 24	2 26	2 28	2 30	2 32	2 34	2 37	2 39	2 41	2 44	2 46	2 49	2 51	2 54	2 56
11	2 21	2 23	2 25	2 27	2 29	2 31	2 33	2 35	2 38	2 40	2 42	2 45	2 47	2 50	2 52	2 55	2 57
12	2 22	2 24	2 26	2 28	2 30	2 32	2 34	2 36	2 39	2 41	2 43	2 46	2 48	2 51	2 53	2 56	2 58
13	2 23	2 25	2 27	2 29	2 31	2 33	2 35	2 37	2 40	2 42	2 44	2 47	2 49	2 52	2 54	2 57	2 59
14	2 24	2 26	2 28	2 30	2 32	2 34	2 36	2 38	2 41	2 43	2 45	2 48	2 50	2 53	2 55	2 58	3 0
15	2 25	2 27	2 29	2 31	2 33	2 35	2 37	2 39	2 42	2 44	2 46	2 49	2 51	2 54	2 56	2 59	3 1
16	2 26	2 28	2 30	2 32	2 34	2 36	2 38	2 40	2 43	2 45	2 47	2 50	2 52	2 55	2 57	3 0	3 2
17	2 27	2 29	2 31	2 33	2 35	2 37	2 39	2 41	2 44	2 46	2 48	2 51	2 53	2 56	2 58	3 1	3 4
18	2 28	2 30	2 32	2 34	2 36	2 38	2 40	2 42	2 45	2 47	2 49	2 52	2 54	2 57	2 59	3 2	3 5
19	2 29	2 31	2 33	2 35	2 37	2 39	2 41	2 43	2 46	2 48	2 50	2 53	2 55	2 58	3 0	3 3	3 6
20	2 30	2 32	2 34	2 36	2 38	2 40	2 42	2 44	2 47	2 49	2 51	2 54	2 56	2 59	3 1	3 4	3 7
21	2 31	2 33	2 35	2 37	2 39	2 41	2 43	2 45	2 48	2 50	2 52	2 55	2 57	3 0	3 2	3 5	3 8
22	2 32	2 34	2 36	2 38	2 40	2 42	2 44	2 46	2 49	2 51	2 53	2 56	2 58	3 1	3 3	3 6	3 9
23	2 33	2 35	2 37	2 39	2 41	2 43	2 45	2 47	2 50	2 52	2 54	2 57	2 59	3 2	3 4	3 7	3 10
24	2 34	2 36	2 38	2 40	2 42	2 44	2 46	2 49	2 51	2 53	2 55	2 58	3 0	3 3	3 5	3 8	3 11
25	2 35	2 37	2 39	2 41	2 43	2 45	2 47	2 50	2 52	2 54	2 56	2 59	3 1	3 4	3 6	3 9	3 12
26	2 36	2 38	2 40	2 42	2 44	2 46	2 48	2 51	2 53	2 55	2 57	3 0	3 2	3 5	3 7	3 10	3 13
27	2 37	2 39	2 41	2 43	2 45	2 47	2 49	2 52	2 54	2 56	3 58	3 1	3 3	3 6	3 8	3 11	3 14
28	2 38	2 40	2 42	2 44	2 46	2 48	2 50	2 53	2 55	2 57	3 0	3 2	3 4	3 7	3 10	3 12	3 15
29	2 39	2 41	2 43	2 45	2 47	2 49	2 51	2 54	2 56	2 58	3 1	3 3	3 5	3 8	3 11	3 13	3 16
30	2 40	2 42	2 44	2 46	2 48	2 50	2 52	2 55	2 57	2 59	3 2	3 4	3 6	3 9	3 12	3 14	3 17
31	2 41	2 43	2 45	2 47	2 49	2 51	2 53	2 56	2 58	3 0	3 3	3 5	3 7	3 10	3 13	3 15	3 18
32	2 42	2 44	2 46	2 48	2 50	2 52	2 54	2 57	2 59	3 1	3 4	3 6	3 8	3 11	3 14	3 16	3 19
33	2 43	2 45	2 47	2 49	2 51	2 53	2 55	2 58	3 0	3 2	3 5	3 7	3 9	3 12	3 15	3 17	3 20
34	2 44	2 46	2 48	2 50	2 52	2 54	2 56	2 59	3 1	3 3	3 6	3 8	3 10	3 13	3 16	3 18	3 21
35	2 45	2 47	2 49	2 51	2 53	2 55	2 57	3 0	3 2	3 4	3 7	3 9	3 11	3 14	3 17	3 19	3 22
36	2 46	2 48	2 50	2 52	2 54	2 56	2 58	3 1	3 3	3 5	3 8	3 10	3 13	3 15	3 18	3 20	3 23
37	2 47	2 49	2 51	2 53	2 55	2 57	2 59	3 2	3 4	3 6	3 9	3 11	3 14	3 16	3 19	3 21	3 24
38	2 48	2 50	2 52	2 54	2 56	2 58	3 0	3 3	3 5	3 7	3 10	3 12	3 15	3 17	3 20	3 22	3 25
39	2 49	2 51	2 53	2 55	2 57	2 59	3 1	3 4	3 6	3 8	3 11	3 13	3 16	3 18	3 21	3 23	3 26
40	2 50	2 52	2 54	2 56	2 58	3 0	3 2	3 5	3 7	3 9	3 12	3 14	3 17	3 19	3 22	3 24	3 27
41	2 51	2 53	2 55	2 57	2 59	3 1	3 3	3 6	3 8	3 10	3 13	3 15	3 18	3 20	3 23	3 25	3 28
42	2 52	2 54	2 56	2 58	3 0	3 2	3 4	3 7	3 9	3 11	3 14	3 16	3 19	3 21	3 24	3 26	3 29
43	2 53	2 55	2 57	2 59	3 1	3 3	3 5	3 8	3 10	3 12	3 15	3 17	3 20	3 22	3 25	3 27	3 30
44	2 54	2 56	2 58	3 0	3 2	3 4	3 6	3 9	3 11	3 13	3 16	3 18	3 21	3 23	3 26	3 28	3 31
45	2 55	2 57	2 59	3 1	3 3	3 5	3 7	3 10	3 12	3 14	3 17	3 19	3 22	3 24	3 27	3 30	3 32
46	2 56	2 58	3 0	3 2	3 4	3 6	3 8	3 11	3 13	3 15	3 18	3 20	3 23	3 25	3 28	3 31	3 33
47	2 57	2 59	3 1	3 3	3 5	3 7	3 9	3 12	3 14	3 16	3 19	3 21	3 24	3 26	3 29	3 32	3 34
48	2 58	3 0	3 2	3 4	3 6	3 8	3 10	3 13	3 15	3 17	3 20	3 22	3 25	3 27	3 30	3 33	3 35
49	2 59	3 1	3 3	3 5	3 7	3 9	3 11	3 14	3 16	3 18	3 21	3 23	3 26	3 28	3 31	3 34	3 36
50	3 0	3 2	3 4	3 6	3 8	3 10	3 12	3 15	3 17	3 19	3 22	3 24	3 27	3 29	3 32	3 35	3 37
50	0 50	0 50	0 50	0 50	0 50	0 50	0 50	0 50	0 50	0 50	0 51	0 51	0 51	0 51	0 51	0 51	0 52
60	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 1	1 1	1 1	1 1	1 1	1 1	1 2	1 2
70	1 10	1 10	1 10	1 10	1 10	1 10	1 10	1 10	1 10	1 11	1 11	1 11	1 11	1 11	1 12	1 12	1 12
80	1 20	1 20	1 20	1 20	1 20	1 20	1 20	1 20	1 21	1 21	1 21	1 21	1 21	1 22	1 22	1 22	1 22
90	1 30	1 30	1 30	1 30	1 30	1 30	1 30	1 30	1 31	1 31	1 31	1 31	1 31	1 32	1 32	1 32	1 33
100	1 40	1 40	1 40	1 40	1 40	1 40	1 40	1 40	1 41	1 41	1 41	1 41	1 42	1 42	1 42	1 43	1 43
150	2 30	2 30	2 30	2 30	2 30	2 30	2 30	2 31	2 31	2 31	2 32	2 32	2 32	2 33	2 33	2 34	2 35
200	3 20	3 20	3 20	3 20	3 20	3 20	3 21	3 21	3 21	3 22	3 22	3 23	3 24	3 24	3 25	3 26	3 26
250	4 10	4 10	4 10	4 10	4 10	4 10	4 11	4 11	4 12	4 12	4 13	4 13	4 14	4 15	4 16	4 17	4 18
300	5 0	5 0	5 0	5 0	5 0	5 0	5 1	5 1	5 2	5 2	5 3	5 4	5 5	5 6	5 7	5 8	5 9

TABLE VI.

First Correction to be added to the Apparent Distance.

Aux. Arc. Table V.	105°	106°	107°	108°	109°	110°	111°	112°	113°	114°	115°	116°	117°	118°	119°	120°	121°
″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
0	2 49	2 51	2 54	2 57	3 0	3 3	3 6	3 9	3 12	3 16	3 19	3 22	3 26	3 30	3 34	3 38	3 42
1	2 50	2 52	2 55	2 58	3 1	3 4	3 7	3 10	3 13	3 17	3 20	3 24	3 27	3 31	3 35	3 39	3 43
2	2 51	2 53	2 56	2 59	3 2	3 5	3 8	3 11	3 14	3 18	3 21	3 25	3 28	3 32	3 36	3 40	3 44
3	2 52	2 54	2 57	3 0	3 3	3 6	3 9	3 12	3 16	3 19	3 22	3 26	3 29	3 33	3 37	3 41	3 45
4	2 53	2 56	2 58	3 1	3 4	3 7	3 10	3 13	3 17	3 20	3 23	3 27	3 31	3 34	3 38	3 42	3 46
5	2 54	2 57	2 59	3 2	3 5	3 8	3 11	3 15	3 18	3 21	3 24	3 28	3 32	3 35	3 39	3 43	3 47
6	2 55	2 58	3 0	3 3	3 6	3 9	3 12	3 16	3 19	3 22	3 26	3 29	3 33	3 37	3 41	3 45	3 49
7	2 56	2 59	3 1	3 4	3 7	3 10	3 13	3 17	3 20	3 23	3 27	3 30	3 34	3 38	3 42	3 46	3 50
8	2 57	3 0	3 2	3 5	3 8	3 11	3 15	3 18	3 21	3 24	3 28	3 31	3 35	3 39	3 43	3 47	3 51
9	2 58	3 1	3 4	3 6	3 9	3 12	3 16	3 19	3 22	3 25	3 29	3 32	3 36	3 40	3 44	3 48	3 52
10	2 59	3 2	3 5	3 7	3 10	3 13	3 17	3 20	3 23	3 27	3 30	3 34	3 37	3 41	3 45	3 49	3 53
11	3 0	3 3	3 6	3 9	3 12	3 15	3 18	3 21	3 24	3 28	3 31	3 35	3 38	3 42	3 46	3 50	3 54
12	3 1	3 4	3 7	3 10	3 13	3 16	3 19	3 22	3 25	3 29	3 32	3 36	3 39	3 43	3 47	3 51	3 56
13	3 2	3 5	3 8	3 11	3 14	3 17	3 20	3 23	3 26	3 30	3 33	3 37	3 41	3 45	3 49	3 53	3 57
14	3 3	3 6	3 9	3 12	3 15	3 18	3 21	3 24	3 28	3 31	3 34	3 38	3 42	3 46	3 50	3 54	3 58
15	3 4	3 7	3 10	3 13	3 16	3 19	3 22	3 25	3 29	3 32	3 35	3 39	3 43	3 47	3 51	3 55	3 59
16	3 5	3 8	3 11	3 14	3 17	3 20	3 23	3 26	3 30	3 33	3 37	3 40	3 44	3 48	3 52	3 56	4 0
17	3 6	3 9	3 12	3 15	3 18	3 21	3 24	3 27	3 31	3 34	3 38	3 41	3 45	3 49	3 53	3 57	4 1
18	3 7	3 10	3 13	3 16	3 19	3 22	3 25	3 29	3 32	3 35	3 39	3 42	3 46	3 50	3 54	3 58	4 3
19	3 8	3 11	3 14	3 17	3 20	3 23	3 26	3 30	3 33	3 36	3 40	3 44	3 47	3 51	3 55	4 0	4 4
20	3 9	3 12	3 15	3 18	3 21	3 24	3 27	3 31	3 34	3 37	3 41	3 45	3 48	3 52	3 56	4 1	4 5
21	3 10	3 13	3 16	3 19	3 22	3 25	3 28	3 32	3 35	3 39	3 42	3 46	3 50	3 54	3 58	4 2	4 6
22	3 11	3 14	3 17	3 20	3 23	3 26	3 29	3 33	3 36	3 40	3 43	3 47	3 51	3 55	3 59	4 3	4 7
23	3 12	3 15	3 18	3 21	3 24	3 27	3 31	3 34	3 37	3 41	3 44	3 48	3 52	3 56	4 0	4 4	4 8
24	3 14	3 16	3 19	3 22	3 25	3 28	3 32	3 35	3 38	3 42	3 45	3 49	3 53	3 57	4 1	4 5	4 10
25	3 15	3 17	3 20	3 23	3 26	3 30	3 33	3 36	3 39	3 43	3 47	3 50	3 54	3 58	4 2	4 6	4 11
26	3 16	3 18	3 21	3 24	3 27	3 31	3 34	3 37	3 41	3 44	3 48	3 51	3 55	3 59	4 3	4 8	4 12
27	3 17	3 19	3 22	3 25	3 28	3 32	3 35	3 38	3 42	3 45	3 49	3 52	3 56	4 0	4 5	4 9	4 13
28	3 18	3 20	3 23	3 26	3 29	3 33	3 36	3 39	3 43	3 46	3 50	3 54	3 57	4 1	4 6	4 10	4 14
29	3 19	3 21	3 24	3 27	3 31	3 34	3 37	3 40	3 44	3 47	3 51	3 55	3 59	4 3	4 7	4 11	4 15
30	3 20	3 23	3 25	3 28	3 32	3 35	3 38	3 41	3 45	3 48	3 52	3 56	4 0	4 4	4 8	4 12	4 17
31	3 21	3 24	3 27	3 30	3 33	3 36	3 39	3 43	3 46	3 49	3 53	3 57	4 1	4 5	4 9	4 13	4 18
32	3 22	3 25	3 28	3 31	3 34	3 37	3 40	3 44	3 47	3 51	3 54	3 58	4 2	4 6	4 10	4 15	4 19
33	3 23	3 26	3 29	3 32	3 35	3 38	3 41	3 45	3 48	3 52	3 55	3 59	4 3	4 7	4 11	4 16	4 20
34	3 24	3 27	3 30	3 33	3 36	3 39	3 42	3 46	3 49	3 53	3 56	4 0	4 4	4 8	4 13	4 17	4 21
35	3 25	3 28	3 31	3 34	3 37	3 40	3 43	3 47	3 50	3 54	3 58	4 1	4 5	4 9	4 14	4 18	4 22
36	3 26	3 29	3 32	3 35	3 38	3 41	3 44	3 48	3 51	3 55	3 59	4 2	4 6	4 11	4 15	4 19	4 24
37	3 27	3 30	3 33	3 36	3 39	3 42	3 46	3 49	3 52	3 56	4 0	4 4	4 8	4 12	4 16	4 20	4 25
38	3 28	3 31	3 34	3 37	3 40	3 43	3 47	3 50	3 54	3 57	4 1	4 5	4 9	4 13	4 17	4 21	4 26
39	3 29	3 32	3 35	3 38	3 41	3 44	3 48	3 51	3 55	3 58	4 2	4 6	4 10	4 14	4 18	4 23	4 27
40	3 30	3 33	3 36	3 39	3 42	3 45	3 49	3 52	3 56	3 59	4 3	4 7	4 11	4 15	4 19	4 24	4 28
41	3 31	3 34	3 37	3 40	3 43	3 47	3 50	3 53	3 57	4 0	4 4	4 8	4 12	4 16	4 21	4 25	4 29
42	3 32	3 35	3 38	3 41	3 44	3 48	3 51	3 54	3 58	4 2	4 5	4 9	4 13	4 17	4 22	4 26	4 31
43	3 33	3 36	3 39	3 42	3 45	3 49	3 52	3 55	3 59	4 3	4 6	4 10	4 14	4 18	4 23	4 27	4 32
44	3 34	3 37	3 40	3 43	3 46	3 50	3 53	3 57	4 0	4 4	4 8	4 11	4 15	4 20	4 24	4 28	4 33
45	3 35	3 38	3 41	3 44	3 47	3 51	3 54	3 58	4 1	4 5	4 9	4 13	4 17	4 21	4 25	4 30	4 34
46	3 36	3 39	3 42	3 45	3 49	3 52	3 55	3 59	4 2	4 6	4 10	4 14	4 18	4 22	4 26	4 31	4 35
47	3 37	3 40	3 43	3 46	3 50	3 53	3 56	4 0	4 3	4 7	4 11	4 15	4 19	4 23	4 27	4 32	4 36
48	3 38	3 41	3 44	3 47	3 51	3 54	3 57	4 1	4 4	4 8	4 12	4 16	4 20	4 24	4 29	4 33	4 38
49	3 39	3 42	3 45	3 48	3 52	3 55	3 58	4 2	4 6	4 9	4 13	4 17	4 21	4 25	4 30	4 34	4 39
50	3 40	3 43	3 46	3 50	3 53	3 56	3 59	4 3	4 7	4 10	4 14	4 18	4 22	4 26	4 31	4 35	4 40
50	0 52	0 52	0 52	0 53	0 53	0 53	0 54	0 54	0 54	0 55	0 55	0 56	0 56	0 57	0 57	0 58	0 58
60	1 2	1 2	1 3	1 3	1 3	1 4	1 4	1 5	1 5	1 6	1 6	1 7	1 7	1 8	1 9	1 9	1 10
70	1 12	1 13	1 13	1 14	1 14	1 14	1 15	1 15	1 16	1 17	1 17	1 18	1 19	1 19	1 20	1 21	1 22
80	1 23	1 23	1 24	1 24	1 25	1 25	1 26	1 26	1 27	1 28	1 28	1 29	1 30	1 31	1 32	1 32	1 33
90	1 33	1 34	1 34	1 35	1 35	1 36	1 36	1 37	1 38	1 38	1 39	1 40	1 41	1 42	1 43	1 44	1 45
100	1 44	1 44	1 45	1 45	1 46	1 46	1 47	1 48	1 49	1 49	1 50	1 51	1 52	1 53	1 54	1 55	1 57
150	2 35	2 36	2 37	2 38	2 39	2 40	2 41	2 42	2 43	2 44	2 45	2 47	2 48	2 50	2 52	2 53	2 55
200	3 27	3 28	3 29	3 30	3 32	3 33	3 34	3 36	3 37	3 39	3 41	3 42	3 44	3 46	3 49	3 51	3 53
250	4 19	4 20	4 21	4 23	4 25	4 26	4 28	4 30	4 32	4 34	4 36	4 38	4 41	4 43	4 46	4 49	4 52
300	5 11	5 12	5 14	5 15	5 17	5 19	5 21	5 24	5 26	5 28	5 31	5 34	5 37	5 40	5 43	5 46	5 50

TABLE VII.

The Sun's Correction to be added to the Observed or Apparent Distance.

For a Planet:—Multiply the ☉'s Correction by the Planet's Hor. Par., and cut off the last figure.

Distance 20°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	10	12	17	..	..	..	..	..	..
10	8	10	15	19	..	..	..	..	..
15	5	7	12	16	20	..	..	..	..
20	2	5	11	14	18	..	..	..	..
25	0	2	7	11	15	19	..	..	..
30	..	0	5	9	13	17	..	..	..
35	..	..	3	7	11	14	17	..	..
40	..	..	1	5	9	12	15	..	..
45	..	..	..	3	7	10	13	15	..
50	..	..	..	1	5	9	11	13	..
60	..	..	..	..	2	6	8	10	12
70	..	..	..	..	..	4	6	8	10
80	..	..	..	..	..	..	5	7	8
85	..	..	..	..	..	..	..	7	..

Distance 25°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	10	11	15	19	..	..	..	..	..
10	8	10	13	17	20	..	..	..	..
15	6	7	11	15	17	..	..	..	..
20	4	5	9	13	16	18	..	..	..
25	2	3	7	11	14	16	19	..	..
30	0	2	6	9	12	15	17	..	..
35	..	0	4	7	10	13	15	..	..
40	..	..	2	6	9	11	13	15	..
45	..	..	1	4	7	10	12	13	..
50	..	..	..	3	6	8	10	12	13
60	..	..	..	0	3	6	8	10	11
70	..	..	..	..	2	4	6	8	9
80	..	..	..	..	..	3	5	7	8
85	..	..	..	..	..	..	5	..	..

Distance 30°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	10	11	14	17	19	..	..	..	..
10	8	9	12	15	18	..	..	..	..
15	6	8	11	13	16	18	..	..	..
20	5	6	9	12	14	16	..	..	..
25	3	5	7	10	13	15	17	..	..
30	2	3	5	9	11	13	15	..	..
35	0	2	4	7	10	12	14	15	..
40	..	0	3	6	8	10	12	13	..
45	..	..	2	5	7	9	11	12	13
50	..	..	1	3	6	8	10	11	12
60	..	..	..	1	4	6	8	9	10
70	..	..	..	..	2	5	6	7	8
80	..	..	..	..	..	4	5	6	..
85	..	..	..	..	..	..	5	..	..

Distance 40°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	10	11	13	15	17	..	..	..	..
10	9	10	12	14	16	17	..	..	..
15	7	8	10	12	14	15	..	..	..
20	6	6	9	11	12	14	15	..	..
25	5	5	8	9	11	13	14	..	..
30	3	4	6	8	10	11	13	14	..
35	2	3	5	7	9	10	11	12	..
40	1	2	4	6	8	9	10	11	12
45	0	1	3	5	7	8	9	10	11
50	..	0	2	4	6	7	8	9	10
60	..	..	1	3	4	6	7	8	8
70	..	..	..	1	3	5	6	7	..
80	..	..	..	..	2	4	5	..	..
85	..	..	..	..	..	4	5	..	..

Distance 50°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	10	10	12	13	14	15	16	..	..
10	9	9	11	12	13	14	15	..	..
15	7	8	10	11	12	13	14	15	..
20	6	7	8	10	11	12	13	13	..
25	5	6	7	9	10	11	12	12	13
30	4	5	6	8	9	10	11	11	12
35	3	4	5	7	8	9	10	10	11
40	2	3	5	6	7	8	9	10	10
45	1	2	4	5	6	7	8	9	9
50	0	1	3	4	5	6	7	8	8
60	..	0	2	3	4	5	6	7	..
70	..	..	1	2	3	4	5	..	..
80	..	..	..	1	2	3	..	..	..
85	..	..	..	1	2	..	..	..	..

Distance 60°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	10	10	11	12	13	13	14	14	..
10	9	9	10	11	12	12	13	13	..
15	7	8	9	10	11	12	12	13	13
20	6	7	8	9	10	11	11	12	12
25	5	6	7	8	9	10	10	11	11
30	4	5	6	7	8	9	9	10	10
35	4	4	5	6	7	8	8	9	9
40	3	3	5	6	6	7	8	8	8
45	2	2	4	5	5	6	7	7	..
50	1	2	3	4	5	6	6	7	..
60	0	1	2	3	4	5	5	..	..
70	..	0	1	2	3	4	..	..	..
80	..	..	1	2	2	..	..	..	..
85	..	..	0	1	..	..	..	..	..

Distance 70°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	9	10	10	11	11	12	12	12	13
10	8	9	9	10	11	11	11	12	12
15	7	8	8	9	10	10	10	11	11
20	6	7	8	8	9	9	9	10	10
25	6	6	7	7	8	8	9	9	9
30	5	5	6	6	7	7	8	8	8
35	4	4	5	6	6	7	7	7	..
40	3	3	4	5	5	6	6	6	..
45	3	3	3	4	5	5	6	..	..
50	2	2	3	4	4	5	5	..	..
60	1	1	2	3	3	4	..	..	..
70	0	0	1	2	2	3	..	..	..
80	0	0	1	1	..	..	..	..	..
85	..	..	0	..	..	..	..	..	..

Distance 80°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	9	9	10	10	10	10	10	11	11
10	8	9	9	9	9	10	10	10	10
15	7	8	8	8	9	9	9	9	9
20	7	7	7	8	8	8	8	8	8
25	6	6	7	7	7	7	7	7	..
30	5	5	6	6	6	6	6	7	..
35	4	4	5	5	5	5	6	..	..
40	3	4	4	4	5	5	5	..	..
45	3	3	3	4	4	..	..	..	..
50	2	2	3	3	3	..	..	..	..
60	1	1	2	2	2	..	..	..	..
70	1	1	1	1	..	..	..	..	..
80	0	0	0	..	..	..	..	..	..
85	0	0	0	..	..	..	..	..	..

Distance 90°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	9	9	9	9	9	9	9	9	9
10	8	8	8	8	8	8	8	8	8
15	7	7	7	7	7	7	7	7	..
20	7	7	7	7	7	7	7	7	..
25	6	6	6	6	6	6	6	..	..
30	5	5	5	5	5	5	5	..	..
35	4	4	4	4	4	4	..	..	..
40	4	4	4	4	4	4	..	..	..
45	3	3	3	3	..	..	..	..	..
50	2	2	2	2	..	..	..	..	..
60	1	1	1	..	..	..	..	..	..
70	1	1	1	..	..	..	..	..	..
80	0	0	..	..	..	..	..	..	..
85	0	..	..	..	..	..	..	..	..

Distance 100°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	9	9	8	8	8	8	8	7	7
10	8	8	8	7	7	7	7	7	7
15	7	7	7	7	6	6	6	..	..
20	6	6	6	6	5	5	5	..	..
25	6	6	5	5	5	4	..	..	..
30	5	5	4	4	4	4	..	..	..
35	4	4	4	3	3	..	..	..	..
40	3	3	3	3	2	..	..	..	..
45	3	3	2	2	..	..	..	..	..
50	2	2	2	1	..	..	..	..	..
60	1	1	1	..	..	..	..	..	..
70	1	0	..	..	..	..	..	..	..
80	0	..	..	..	..	..	..	..	..
85	..	..	..	..	..	..	..	..	..

Distance 110°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	9	8	8	7	7	6	6	6	5
10	8	8	7	6	6	5	5	..	..
15	7	7	6	5	5	4	..	..	..
20	6	6	5	5	4	3	..	..	..
25	5	5	4	4	3	..	..	..	..
30	5	5	4	3	2	..	..	..	..
35	4	4	3	2	..	..	..	..	..
40	3	3	2	1	..	..	..	..	..
45	2	2	1	..	..	..	..	..	..
50	2	2	1	..	..	..	..	..	..
60	1	1	..	..	..	..	..	..	..
70	0	..	..	..	..	..	..	..	..
80	..	..	..	..	..	..	..	..	..
85	..	..	..	..	..	..	..	..	..

Distance 120°

☽'s Alt.	☉'s Altitude. 5°	10°	20°	30°	40°	50°	60°	70°	80°
	″	″	″	″	″	″	″	″	″
5°	9	8	7	6	5	5	4	..	..
10	8	7	6	5	4	4	..	..	..
15	7	7	5	4	3	..	..	..	..
20	6	6	4	3	2	..	..	..	..
25	5	5	3	2	..	..	..	..	..
30	4	4	2	1	..	..	..	..	..
35	3	3	1	..	..	..	..	..	..
40	2	2	1	..	..	..	..	..	..
45	2	1	..	..	..	..	..	..	..
50	1	..	..	..	..	..	..	..	..
60	0	..	..	..	..	..	..	..	..
70	..	..	..	..	..	..	..	..	..
80	..	..	..	..	..	..	..	..	..
85	..	..	..	..	..	..	..	..	..

TABLE VIII.

The Correction for Departure.

For the *Departure of the* ☽ *in Altitude* (Meth. 3d), the Correction is always to be *added* to the Observed or App. Dist.

The Correction for the *Departure of Dist.*, is always *West*; but for the ☉, it must be increased by 10″; and, for a *Planet*, by its Horizontal Parallax.

Dep. in Alt. or Dist.	Distance.																			
	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	40°	42°
′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
0	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
5	21	21	21	21	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
10	22	22	22	22	22	22	22	22	22	22	22	21	21	21	21	21	21	21	21	21	21
12	23	23	23	23	23	23	23	22	22	22	22	22	22	22	22	22	22	22	22	21	21
14	25	24	24	24	24	24	24	23	23	23	23	23	23	23	23	22	22	22	22	22	22
16	26	26	26	25	25	25	25	24	24	24	24	24	24	23	23	23	23	23	23	23	22
17	27	27	26	26	26	25	25	25	25	25	24	24	24	24	24	24	23	23	23	23	23
18	28	27	27	27	26	26	26	26	25	25	25	25	25	24	24	24	24	24	24	23	23
19	29	28	28	27	27	27	26	26	26	26	25	25	25	25	25	24	24	24	24	24	23
20	30	29	29	28	28	27	27	27	27	26	26	26	26	25	25	25	25	25	24	24	24
21	31	30	30	29	29	28	28	28	27	27	27	26	26	26	26	25	25	25	25	25	24
22	32	31	30	30	29	29	29	28	28	28	27	27	27	27	26	26	26	26	25	25	25
23	33	32	31	31	30	30	29	29	29	28	28	28	27	27	27	27	26	26	26	26	25
24	34	33	32	32	31	31	30	30	29	29	29	28	28	28	27	27	27	27	26	26	26
25	35	34	33	33	32	32	31	31	30	30	29	29	29	28	28	28	28	27	27	26	26
26	36	35	35	34	33	33	32	32	31	31	30	30	29	29	29	28	28	28	28	27	27
27	37	37	36	35	34	33	33	32	32	31	31	31	30	30	29	29	29	28	28	28	27
28	39	38	37	36	35	35	34	33	33	32	32	31	31	31	30	30	29	29	29	28	28
29	40	39	38	37	36	36	35	34	34	33	33	32	32	31	31	30	30	30	29	29	28
30	42	40	39	39	38	37	36	35	35	34	34	33	33	32	32	31	31	30	30	29	29
31	43	42	41	40	39	38	37	36	36	35	35	34	33	33	32	32	32	31	31	30	29
32	45	43	42	41	40	39	38	38	37	36	35	35	34	34	33	33	32	32	31	31	30
33	46	45	44	42	41	40	39	39	38	37	36	36	35	35	34	34	33	33	32	31	31
34	48	46	45	44	43	42	41	40	39	38	37	37	36	36	35	34	34	33	33	32	31
35	49	48	46	45	44	43	42	41	40	39	39	38	37	36	36	35	35	34	34	33	32
36	51	49	48	47	45	44	43	42	41	40	40	39	38	37	37	36	36	35	34	33	33
37	53	51	50	48	47	46	44	43	42	42	41	40	39	38	38	37	36	36	35	34	33
38	55	53	51	50	48	47	46	45	44	43	42	41	40	39	39	38	37	37	36	35	34
39	56	55	53	51	50	48	47	46	45	44	43	42	41	40	40	39	38	38	37	36	35
40	58	56	55	53	51	50	49	47	46	45	44	43	42	41	41	40	39	39	38	37	36
41	60	58	56	55	53	51	50	49	48	46	45	44	43	43	42	41	40	39	39	37	36
42	62	60	58	56	55	53	52	50	49	48	47	46	45	44	43	42	41	40	40	38	37
43	64	62	60	58	56	55	53	52	50	49	48	47	46	45	44	43	42	41	41	39	38
44	66	64	62	60	58	56	55	53	52	50	49	48	47	46	45	44	43	42	42	40	39
45	69	66	64	62	60	58	56	55	53	52	51	49	48	47	46	45	44	43	43	41	40
46	71	68	66	63	61	60	58	56	55	53	52	51	50	48	47	46	45	45	44	42	41
47	73	70	68	65	63	61	60	58	56	55	53	52	51	50	49	48	47	46	45	43	41
48	75	72	70	67	65	63	61	59	58	56	55	53	52	51	50	49	48	47	46	44	42
49	78	75	72	69	67	65	63	61	59	58	56	55	54	52	51	50	49	48	47	45	43
50	80	77	74	71	69	67	65	63	61	59	58	56	55	54	52	51	50	49	48	46	44
51	82	79	76	73	71	69	67	65	63	61	59	58	56	55	54	52	51	50	49	47	45
52	85	81	78	76	73	71	68	66	64	63	61	59	58	56	55	54	52	51	50	48	46
53	87	84	81	78	75	73	70	68	66	64	62	61	59	58	56	55	54	53	51	49	47
54	90	86	83	80	77	75	72	70	68	66	64	62	61	59	58	56	55	54	53	50	48
55	92	89	85	82	79	77	74	72	70	68	66	64	62	61	59	58	56	55	54	51	49
56	95	91	88	84	81	79	76	74	71	69	67	66	64	62	61	59	58	56	55	53	50
57	98	94	90	87	84	81	78	76	73	71	69	67	65	64	62	60	59	58	56	54	51
58	101	96	93	89	86	83	80	78	75	73	71	69	67	65	64	62	60	59	58	55	53
59	103	99	95	92	88	85	82	80	77	75	73	71	69	67	65	63	62	60	59	56	54
60	106	102	98	94	91	87	84	82	79	77	74	72	70	68	67	65	63	62	60	57	55
61	109	105	100	96	93	90	87	84	81	79	76	74	72	70	68	66	65	63	62	59	56
62	112	107	103	99	95	92	89	86	83	80	78	76	74	72	70	68	66	65	63	60	57
63	115	110	106	102	98	94	91	88	85	82	80	78	75	73	71	69	67	66	64	61	58
′	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	40°	42°

TABLE VIII.

The Correction for Departure.

For the *Departure of the* ☽ *in Altitude* (Meth. 2d), the Correction is always to be *added* to the Observed or App. Dist.

The Correction for the *Departure of Dist.*, is always *West*; but for the ☉, it must be increased by 10″; and, for a *Planet*, by its Horizontal Parallax.

Dep. in Alt. or Dist.	DISTANCE.																					
	44°	46°	48°	50°	52°	54°	56°	58°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°
′	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
0	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
5	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
10	21	21	21	21	21	21	21	21	21	20	20	20	20	20	20	20	20	20	20	20	19
12	21	21	21	21	21	21	21	21	21	21	20	20	20	20	20	20	20	20	20	19	19
14	22	22	22	21	21	21	21	21	21	21	21	20	20	20	20	20	20	20	19	19	19
16	22	22	22	22	22	22	22	21	21	21	21	21	20	20	20	20	20	19	19	19	19
17	23	22	22	22	22	22	22	22	21	21	21	21	20	20	20	20	20	19	19	19	19
18	23	23	23	22	22	22	22	22	22	21	21	21	20	20	20	20	20	19	19	19	18
19	23	23	23	23	22	22	22	22	22	21	21	21	21	20	20	20	19	19	19	19	18
20	24	23	23	23	23	23	22	22	22	22	21	21	21	20	20	20	19	19	19	18	18
21	24	24	23	23	23	23	23	22	22	22	21	21	21	20	20	20	19	19	19	18	18
22	25	24	24	24	23	23	23	23	22	22	22	21	21	20	20	20	19	19	18	18	18
23	25	24	24	24	24	23	23	23	23	22	22	21	21	20	20	20	19	19	18	18	17
24	25	25	25	24	24	24	23	23	23	22	22	21	21	20	20	20	19	19	18	18	17
25	26	25	25	25	24	24	24	23	23	23	22	21	21	20	20	20	19	19	18	17	17
26	26	26	25	25	25	24	24	24	23	23	22	22	21	21	20	19	19	18	18	17	17
27	27	26	26	25	25	25	24	24	24	23	22	22	21	21	20	19	19	18	18	17	16
28	27	27	26	26	25	25	25	24	24	23	22	22	21	21	20	19	19	18	18	17	16
29	28	27	27	26	26	25	25	25	24	23	23	22	21	21	20	19	19	18	17	17	16
30	28	28	27	27	26	26	25	25	25	24	23	22	21	21	20	19	19	18	17	16	15
31	29	28	28	27	27	26	26	25	25	24	23	22	21	21	20	19	19	18	17	16	15
32	29	29	28	27	27	26	26	26	25	24	23	22	22	21	20	19	18	18	17	16	15
33	30	29	29	28	27	27	26	26	25	24	23	23	22	21	20	19	18	17	17	16	15
34	30	30	29	28	28	27	27	26	26	25	24	23	22	21	20	19	18	17	16	15	14
35	31	30	30	29	28	28	27	27	26	25	24	23	22	21	20	19	18	17	16	15	14
36	32	31	30	29	29	28	28	27	27	25	24	23	22	21	20	19	18	17	16	15	13
37	32	32	31	30	29	29	28	27	27	26	24	23	22	21	20	19	18	17	16	14	13
38	33	32	31	31	30	29	28	28	27	26	25	23	22	21	20	19	18	17	15	14	13
39	34	33	32	31	30	30	29	28	28	26	25	24	22	21	20	19	18	16	15	14	12
40	34	33	33	32	31	30	29	29	28	27	25	24	22	21	20	19	18	16	15	13	12
41	35	34	33	32	31	31	30	29	28	27	25	24	23	21	20	19	17	16	15	13	12
42	36	35	34	33	32	31	30	30	29	27	26	24	23	21	20	19	17	16	14	13	11
43	37	36	35	34	33	32	31	30	29	28	26	24	23	21	20	19	17	16	14	12	11
44	37	36	35	34	33	32	31	31	30	28	26	25	23	21	20	19	17	15	14	12	10
45	38	37	36	35	34	33	32	31	30	28	26	25	23	22	20	18	17	15	14	12	10
46	39	38	37	35	34	33	32	32	31	29	27	25	23	22	20	18	17	15	13	11	9
47	40	39	37	36	35	34	33	32	31	29	27	25	23	22	20	18	17	15	13	11	9
48	41	39	38	37	36	35	34	33	32	29	27	25	24	22	20	18	16	15	13	11	8
49	42	40	39	38	36	35	34	33	32	30	28	26	24	22	20	18	16	14	12	10	8
50	43	41	40	38	37	36	35	34	33	30	28	26	24	22	20	18	16	14	12	10	7
51	44	42	40	39	38	36	35	34	33	31	28	26	24	22	20	18	16	14	12	9	7
52	44	43	41	40	38	37	36	35	34	31	29	26	24	22	20	18	16	14	11	9	6
53	45	44	42	41	39	38	37	35	34	31	29	27	24	22	20	18	16	13	11	9	6
54	46	45	43	41	40	38	37	36	35	32	29	27	24	22	20	18	16	13	11	8	5
55	47	45	44	42	41	39	38	36	35	32	30	27	25	22	20	18	15	13	10	8	5
56	48	46	45	43	41	40	38	37	36	33	30	27	25	22	20	18	15	13	10	7	4
57	49	47	46	44	42	41	39	38	36	33	30	28	25	22	20	18	15	12	10	7	4
58	50	48	46	45	43	41	40	38	37	34	31	28	25	23	20	17	15	12	9	6	3
59	51	49	47	45	44	42	40	39	38	34	31	28	25	23	20	17	15	12	9	6	2
60	53	50	48	46	45	43	41	40	38	35	31	28	26	23	20	17	14	12	9	5	2
61	54	51	49	47	45	44	42	40	39	35	32	29	26	23	20	17	14	11	8	5	1
62	55	52	50	48	46	44	43	41	39	36	32	29	26	23	20	17	14	11	8	4	1
63	56	53	51	49	47	45	43	42	40	36	33	29	26	23	20	17	14	11	7	4	0
′	44°	46°	48°	50°	52°	54°	56°	58°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	6 Degrees.			7 Degrees.			8 Degrees.			9 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.0192	9.0216	0.9808	9.0859	9.0891	0.9141	9.1436	9.1478	0.8564	9.1943	9.1997	0.8057	0
1	0204	0228	9796	0869	0902	9131	1445	1487	8555	1951	2005	8049	1
2	0216	0240	9784	0879	0912	9121	1453	1496	8547	1959	2013	8041	2
3	0228	0253	9772	0890	0923	9110	1462	1505	8538	1967	2022	8033	3
4	0240	0265	9760	0900	0933	9100	1471	1515	8529	1975	2030	8025	4
5	0252	0277	9748	0910	0943	9090	1480	1524	8520	1983	2038	8017	5
6	0264	0289	9736	0920	0954	9080	1489	1533	8511	1991	2046	8009	6
7	0276	0300	9724	0930	0964	9070	1498	1542	8502	1999	2054	8001	7
8	0287	0312	9713	0940	0974	9060	1507	1551	8493	2007	2062	7993	8
9	0299	0324	9701	0951	0984	9049	1516	1560	8484	2015	2070	7985	9
10	9.0311	9.0336	0.9689	9.0961	9.0995	0.9039	9.1525	9.1569	0.8475	9.2022	9.2078	0.7978	10
11	0323	0348	9677	0971	1005	9029	1533	1578	8467	2030	2086	7970	11
12	0334	0360	9666	0981	1015	9019	1542	1587	8458	2038	2094	7962	12
13	0346	0371	9654	0991	1025	9009	1551	1596	8449	2046	2102	7954	13
14	0357	0383	9643	1001	1035	8999	1560	1605	8440	2054	2110	7946	14
15	0369	0395	9631	1011	1045	8989	1568	1613	8432	2061	2118	7939	15
16	0380	0407	9620	1020	1055	8980	1577	1622	8423	2069	2126	7931	16
17	0392	0418	9608	1030	1066	8970	1586	1631	8414	2077	2134	7923	17
18	0403	0430	9596	1040	1076	8960	1594	1640	8406	2085	2142	7915	18
19	0415	0441	9585	1050	1086	8950	1603	1649	8397	2092	2150	7908	19
20	9.0426	9.0453	0.9574	9.1060	9.1096	0.8940	9.1612	9.1658	0.8388	9.2100	9.2158	0.7900	20
21	0438	0464	9562	1070	1106	8930	1620	1667	8380	2108	2166	7892	21
22	0449	0476	9551	1080	1116	8920	1629	1675	8371	2115	2174	7885	22
23	0460	0487	9540	1089	1125	8911	1637	1684	8363	2123	2181	7877	23
24	0472	0499	9528	1099	1135	8901	1646	1693	8354	2131	2189	7869	24
25	0483	0510	9517	1108	1145	8891	1655	1702	8345	2138	2197	7862	25
26	0494	0521	9506	1118	1155	8882	1663	1710	8337	2146	2205	7854	26
27	0505	0533	9495	1128	1165	8872	1672	1719	8328	2153	2213	7847	27
28	0516	0544	9484	1138	1175	8862	1680	1728	8320	2161	2221	7839	28
29	0527	0555	9473	1147	1185	8853	1689	1736	8311	2169	2228	7831	29
30	9.0539	9.0567	0.9461	9.1157	9.1194	0.8843	9.1697	9.1745	0.8303	9.2176	9.2236	0.7824	30
31	0550	0578	9450	1167	1204	8833	1705	1754	8295	2184	2244	7816	31
32	0561	0589	9439	1176	1214	8824	1714	1762	8286	2191	2251	7809	32
33	0572	0600	9428	1186	1223	8814	1722	1771	8278	2199	2259	7801	33
34	0583	0611	9417	1195	1233	8805	1731	1779	8269	2206	2267	7794	34
35	0594	0622	9406	1205	1243	8795	1739	1788	8261	2214	2275	7786	35
36	0605	0633	9395	1214	1252	8786	1747	1797	8253	2221	2282	7779	36
37	0616	0645	9384	1224	1262	8776	1756	1805	8244	2229	2290	7771	37
38	0626	0656	9374	1233	1272	8767	1764	1814	8236	2236	2298	7764	38
39	0637	0667	9363	1242	1281	8758	1772	1822	8228	2243	2305	7757	39
40	9.0648	9.0678	0.9352	9.1252	9.1291	0.8748	9.1781	9.1831	8219	9.2250	9.2313	0.7749	40
41	0659	0688	9341	1261	1300	8739	1789	1839	8211	2258	2321	7742	41
42	0670	0699	9330	1271	1310	8729	1797	1848	8203	2266	2328	7734	42
43	0680	0710	9320	1280	1319	8720	1806	1856	8194	2273	2336	7727	43
44	0691	0721	9309	1289	1329	8711	1814	1864	8186	2280	2343	7720	44
45	0702	0732	9298	1299	1338	8701	1822	1873	8178	2288	2351	7712	45
46	0712	0743	9288	1308	1348	8692	1830	1881	8170	2295	2359	7705	46
47	0723	0754	9277	1317	1357	8683	1838	1890	8162	2303	2366	7697	47
48	0734	0764	9266	1326	1367	8674	1847	1898	8153	2310	2374	7690	48
49	0744	0775	9256	1336	1376	8664	1855	1906	8145	2317	2381	7683	49
50	9.0755	9.0786	0.9245	9.1345	9.1385	0.8655	9.1863	9.1915	0.8137	9.2324	9.2389	0.7676	50
51	0765	0796	9235	1354	1395	8646	1871	1923	8129	2332	2397	7668	51
52	0776	0807	9224	1363	1404	8637	1879	1931	8121	2339	2404	7661	52
53	0786	0818	9214	1372	1413	8628	1887	1940	8113	2346	2411	7654	53
54	0797	0828	9203	1381	1423	8619	1895	1948	8105	2353	2419	7647	54
55	0807	0839	9193	1390	1432	8610	1903	1956	8097	2361	2426	7630	55
56	0818	0849	9182	1399	1441	8601	1911	1964	8089	2368	2434	7632	56
57	0828	0860	9172	1409	1450	8592	1919	1973	8081	2375	2441	7625	57
58	0838	0871	9162	1418	1460	8582	1927	1981	8073	2382	2448	7618	58
59	0849	0881	9151	1427	1469	8573	1935	1989	8065	2390	2456	7610	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	10 Degrees.			11 Degrees.			12 Degrees.			13 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.2397	9.2463	0.7603	9.2806	9.2887	0.7194	9.3179	9.3275	0.6821	9.3521	9.3634	0.6479	0
1	2404	2471	7596	2812	2893	7188	3185	3281	6815	3526	3639	6474	1
2	2411	2478	7589	2819	2900	7181	3191	3287	6809	3532	3645	6468	2
3	2418	2485	7582	2825	2907	7175	3197	3293	6803	3537	3651	6463	3
4	2425	2493	7575	2832	2913	7168	3202	3300	6798	3543	3657	6457	4
5	2432	2500	7568	2838	2920	7162	3208	3306	6792	3548	3662	6452	5
6	2439	2507	7561	2845	2927	7155	3214	3312	6786	3554	3668	6446	6
7	2447	2515	7553	2851	2934	7149	3220	3318	6780	3559	3674	6441	7
8	2454	2522	7546	2858	2940	7142	3226	3324	6774	3564	3680	6436	8
9	2461	2529	7539	2864	2947	7136	3232	3330	6768	3570	3685	6430	9
10	9.2468	9.2536	0.7532	9.2870	9.2953	0.7130	9.3238	9.3336	0.6762	9.3575	9.3691	0.6425	10
11	2475	2544	7525	2877	2960	7123	3244	3343	6756	3581	3697	6419	11
12	2482	2551	7518	2883	2967	7117	3250	3349	6751	3586	3702	6414	12
13	2489	2558	7511	2890	2973	7110	3255	3355	6745	3591	3708	6409	13
14	2496	2565	7504	2896	2980	7104	3261	3361	6739	3597	3714	6403	14
15	2503	2573	7497	2902	2987	7098	3267	3367	6733	3602	3719	6398	15
16	2510	2580	7490	2909	2993	7091	3273	3373	6727	3608	3725	6392	16
17	2517	2587	7483	2915	3000	7085	3279	3379	6721	3613	3731	6387	17
18	2524	2594	7476	2921	3006	7079	3284	3385	6716	3618	3736	6382	18
19	2531	2601	7469	2928	3013	7072	3290	3391	6710	3624	3742	6376	19
20	9.2538	9.2609	0.7462	9.2934	9.3020	0.7066	9.3296	9.3397	0.6704	9.3629	9.3748	0.6371	20
21	2545	2616	7455	2940	3026	7060	3302	3403	6698	3634	3753	6366	21
22	2551	2623	7449	2947	3033	7053	3308	3409	6692	3640	3759	6360	22
23	2558	2630	7442	2953	3039	7047	3313	3416	6687	3645	3764	6355	23
24	2565	2637	7435	2959	3046	7041	3319	3422	6681	3650	3770	6350	24
25	2572	2644	7428	2965	3052	7035	3325	3428	6675	3655	3776	6345	25
26	2579	2651	7421	2971	3059	7028	3331	3434	6669	3661	3781	6339	26
27	2586	2658	7414	2978	3065	7022	3336	3440	6664	3666	3787	6334	27
28	2593	2666	7407	2984	3072	7016	3342	3446	6658	3671	3792	6329	28
29	2600	2673	7400	2990	3078	7010	3348	3452	6652	3677	3798	6323	29
30	9.2606	9.2680	0.7394	9.2997	9.3085	0.7003	9.3353	9.3458	0.6647	9.3682	9.3804	0.6318	30
31	2613	2687	7387	3003	3091	6997	3359	3464	6641	3687	3809	6313	31
32	2620	2694	7380	3009	3098	6991	3365	3469	6635	3692	3815	6308	32
33	2627	2701	7373	3015	3104	6985	3370	3475	6630	3698	3820	6302	33
34	2634	2708	7366	3021	3110	6979	3376	3481	6624	3703	3826	6297	34
35	2640	2715	7360	3027	3117	6973	3382	3487	6618	3708	3831	6292	35
36	2647	2722	7353	3034	3123	6966	3387	3493	6613	3713	3837	6287	36
37	2654	2729	7346	3040	3130	6960	3393	3499	6607	3719	3842	6281	37
38	2661	2736	7339	3046	3136	6954	3399	3505	6601	3724	3848	6276	38
39	2667	2743	7333	3052	3142	6948	3404	3511	6596	3729	3853	6271	39
40	9.2674	9.2750	0.7326	9.3058	9.3149	0.6942	9.3410	9.3517	0.6590	9.3734	9.3859	0.6266	40
41	2681	2757	7319	3064	3155	6936	3416	3523	6584	3739	3864	6261	41
42	2687	2764	7313	3070	3162	6930	3421	3529	6579	3745	3870	6255	42
43	2694	2770	7306	3077	3168	6924	3427	3535	6573	3750	3875	6250	43
44	2701	2777	7299	3083	3174	6917	3432	3541	6568	3755	3881	6245	44
45	2707	2784	7293	3089	3181	6911	3438	3546	6562	3760	3886	6240	45
46	2714	2791	7286	3095	3187	6905	3444	3552	6556	3765	3892	6235	46
47	2721	2798	7279	3101	3193	6899	3449	3558	6551	3770	3897	6230	47
48	2727	2805	7273	3107	3200	6893	3455	3564	6545	3775	3903	6225	48
49	2734	2812	7266	3113	3206	6887	3460	3570	6540	3781	3908	6219	49
50	9.2740	9.2819	0.7260	9.3119	9.3212	0.6881	9.3466	9.3576	0.6534	9.3786	9.3914	0 6214	50
51	2747	2825	7253	3125	3219	6875	3471	3581	6529	3791	3919	6209	51
52	2754	2832	7246	3131	3225	6869	3477	3587	6523	3796	3924	6204	52
53	2760	2839	7240	3137	3231	6863	3482	3593	6518	3801	3930	6199	53
54	2767	2846	7233	3143	3237	6857	3488	3599	6512	3806	3935	6194	54
55	2773	2853	7227	3149	3244	6851	3493	3605	6507	3811	3941	6189	55
56	2780	2859	7220	3155	3250	6845	3499	3611	6501	3816	3946	6184	56
57	2786	2866	7214	3161	3256	6839	3504	3616	6496	3822	3952	6178	57
58	2793	2873	7207	3167	3262	6833	3510	3622	6490	3827	3957	6173	58
59	2799	2880	7201	3173	3269	6827	3515	3628	6485	3832	3962	6168	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	14 Degrees.			15 Degrees.			16 Degrees.			17 Degrees.			M
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.3837	9.3968	0.6163	9.4130	9.4281	0.5870	9.4403	9.4575	0.5597	9.4659	9.4853	0.5341	0
1	3842	3973	6158	4135	4286	5865	4408	4580	5592	4663	4858	5337	1
2	3847	3978	6153	4139	4291	5861	4412	4584	5588	4668	4862	5332	2
3	3852	3984	6148	4144	4296	5856	4417	4589	5583	4672	4867	5328	3
4	3857	3989	6143	4149	4301	5851	4421	4594	5579	4676	4871	5324	4
5	3862	3995	6138	4153	4306	5847	4425	4599	5575	4680	4876	5320	5
6	3867	4000	6133	4158	4311	5842	4430	4603	5570	4684	4880	5316	6
7	3872	4005	6128	4163	4316	5837	4434	4608	5566	4688	4885	5312	7
8	3877	4011	6123	4168	4321	5832	4438	4613	5562	4692	4889	5308	8
9	3882	4016	6118	4172	4326	5828	4443	4618	5557	4696	4894	5304	9
10	9.3887	9.4021	0.6113	9.4177	9.4331	0.5823	9.4447	9.4622	0.5553	9.4700	9.4899	0.5300	10
11	3892	4027	6108	4182	4336	5819	4452	4627	5548	4705	4903	5295	11
12	3897	4032	6103	4186	4341	5814	4456	4632	5544	4709	4907	5291	12
13	3902	4037	6098	4191	4346	5809	4460	4637	5540	4713	4912	5287	13
14	3907	4042	6093	4195	4351	5805	4465	4641	5535	4717	4916	5283	14
15	3912	4048	6088	4200	4356	5800	4469	4646	5531	4721	4921	5279	15
16	3917	4053	6083	4205	4361	5795	4473	4651	5527	4725	4925	5275	16
17	3922	4058	6078	4209	4366	5791	4478	4655	5522	4729	4930	5271	17
18	3927	4064	6073	4214	4371	5786	4482	4660	5518	4733	4934	5267	18
19	3932	4069	6068	4219	4376	5781	4486	4665	5514	4737	4939	5263	19
20	9.3937	9.4074	0.6063	9.4223	9.4381	0.5777	9.4491	9.4669	0.5509	9.4741	9.4943	0.5259	20
21	3942	4079	6058	4228	4386	5772	4495	4674	5505	4745	4947	5255	21
22	3947	4085	6053	4232	4390	5768	4499	4679	5501	4749	4952	5251	22
23	3952	4090	6048	4237	4395	5763	4503	4683	5497	4753	4956	5247	23
24	3957	4095	6043	4242	4400	5758	4508	4688	5492	4757	4961	5243	24
25	3962	4100	6039	4246	4405	5754	4512	4693	5488	4761	4965	5239	25
26	3966	4106	6034	4251	4410	5749	4516	4697	5484	4765	4970	5235	26
27	3971	4111	6029	4255	4415	5745	4521	4702	5479	4769	4974	5231	27
28	3976	4116	6024	4260	4420	5740	4525	4707	5475	4773	4978	5227	28
29	3981	4121	6019	4264	4425	5736	4529	4711	5471	4777	4983	5223	29
30	9.3986	9.4127	0.6014	9.4269	9.4430	0.5731	9.4533	9.4716	0.5467	9.4781	9.4987	0 5219	30
31	3991	4132	6009	4274	4435	5726	4538	4721	5462	4785	4992	5215	31
32	3996	4137	6004	4278	4440	5722	4542	4725	5458	4789	4996	5211	32
33	4001	4142	5999	4283	4445	5717	4546	4730	5454	4793	5000	5207	33
34	4005	4147	5995	4287	4449	5713	4550	4735	5450	4797	5005	5203	34
35	4010	4153	5990	4292	4454	5708	4555	4739	5445	4801	5009	5199	35
36	4015	4158	5985	4296	4459	5704	4559	4744	5441	4805	5014	5195	36
37	4020	4163	5980	4301	4464	5699	4563	4748	5437	4809	5018	5191	37
38	4025	4168	5975	4305	4469	5695	4567	4753	5433	4813	5022	5187	38
39	4030	4173	5970	4310	4474	5690	4572	4758	5428	4817	5027	5183	39
40	9.4035	9.4178	0.5965	9.4314	9.4479	0.5686	9.4576	9.4762	0.5424	9.4821	9.5031	0.5179	40
41	4039	4184	5961	4319	4484	5681	4580	4767	5420	4825	5035	5175	41
42	4044	4189	5956	4323	4488	5677	4584	4771	5416	4829	5040	5171	42
43	4049	4194	5951	4328	4493	5672	4588	4776	5412	4833	5044	5167	43
44	4054	4199	5946	4332	4498	5668	4593	4781	5407	4837	5049	5163	44
45	4059	4204	5941	4337	4503	5663	4597	4785	5403	4841	5053	5159	45
46	4063	4209	5937	4341	4508	5659	4601	4790	5399	4845	5057	5155	46
47	4068	4214	5932	4346	4513	5654	4605	4794	5395	4849	5062	5151	47
48	4073	4220	5927	4350	4517	5650	4609	4799	5391	4853	5066	5147	48
49	4078	4225	5922	4355	4522	5645	4614	4803	5386	4857	5070	5143	49
50	9.4083	9.4230	0.5917	9.4359	9.4527	0.5641	9.4618	9.4808	0.5382	9.4861	9.5075	0.5139	50
51	4087	4235	5913	4364	4532	5636	4622	4813	5378	4865	5079	5135	51
52	4092	4240	5908	4368	4537	5632	4626	4817	5374	4869	5083	5131	52
53	4097	4245	5903	4372	4541	5628	4630	4822	5370	4873	5088	5127	53
54	4102	4250	5898	4377	4546	5623	4634	4826	5366	4876	5092	5124	54
55	4106	4255	5894	4381	4551	5619	4639	4831	5361	4880	5096	5120	55
56	4111	4260	5889	4386	4556	5614	4643	4835	5357	4884	5101	5116	56
57	4116	4265	5884	4390	4561	5610	4647	4840	5353	4888	5105	5112	57
58	4121	4270	5879	4395	4565	5605	4651	4844	5349	4892	5109	5108	58
59	4125	4275	5875	4399	4570	5601	4655	4849	5345	4896	5113	5104	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	18 Degrees.			19 Degrees.			20 Degrees.			21 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.4900	9.5118	0.5100	9.5126	9.5370	0.4874	9.5341	9.5611	0.4659	9.5543	9.5842	0.4457	0
1	4904	5122	5096	5130	5374	4870	5344	5615	4656	5547	5846	4453	1
2	4908	5126	5092	5134	5378	4866	5347	5619	4653	5550	5849	4450	2
3	4911	5131	5089	5137	5382	4863	5351	5622	4649	5553	5853	4447	3
4	4915	5135	5085	5141	5386	4859	5354	5626	4646	5556	5857	4444	4
5	4919	5139	5081	5145	5390	4855	5358	5630	4642	5560	5861	4440	5
6	4923	5143	5077	5148	5394	4852	5361	5634	4639	5563	5864	4437	6
7	4927	5148	5073	5152	5398	4848	5365	5638	4635	5566	5868	4434	7
8	4931	5152	5069	5156	5402	4844	5368	5642	4632	5570	5872	4430	8
9	4935	5156	5065	5159	5407	4841	5372	5646	4628	5573	5876	4427	9
10	9.4939	9.5161	0.5061	9.5163	9.5411	0.4837	9.5375	9.5650	0.4625	9.5576	9.5879	0.4424	10
11	4942	5165	5058	5167	5415	4836	5379	5654	4621	5579	5883	4421	11
12	4946	5169	5054	5170	5419	4830	5382	5658	4618	5583	5887	4417	12
13	4950	5173	5050	5174	5423	4826	5385	5662	4615	5586	5891	4414	13
14	4954	5178	5046	5177	5427	4823	5389	5665	4611	5589	5894	4411	14
15	4958	5182	5042	5181	5431	4819	5392	5669	4608	5592	5898	4408	15
16	4962	5186	5038	5185	5435	4815	5396	5673	4604	5596	5902	4404	16
17	4965	5190	5035	5188	5439	4812	5399	5677	4601	5599	5906	4401	17
18	4969	5195	5031	5192	5443	4808	5402	5681	4598	5602	5909	4398	18
19	4973	5199	5027	5196	5447	4804	5406	5685	4594	5605	5913	4395	19
20	9.4977	9.5203	0.5023	9.5199	9.5451	0.4801	9.5409	9.5689	0.4591	9.5609	9.5917	0.4391	20
21	4981	5207	5019	5203	5455	4797	5413	5693	4587	5612	5921	4388	21
22	4984	5212	5016	5206	5459	4794	5416	5696	4584	5615	5924	4385	22
23	4988	5216	5012	5210	5463	4790	5420	5700	4580	5618	5928	4382	23
24	4992	5220	5008	5213	5467	4787	5423	5704	4577	5621	5932	4379	24
25	4996	5224	5004	5217	5471	4783	5426	5708	4574	5625	5935	4375	25
26	5000	5228	5000	5221	5475	4779	5430	5712	4570	5628	5939	4372	26
27	5003	5233	4997	5224	5479	4776	5433	5716	4567	5631	5943	4369	27
28	5007	5237	4993	5228	5483	4772	5436	5720	4564	5634	5947	4366	28
29	5011	5241	4989	5231	5487	4769	5440	5724	4560	5638	5950	4362	29
30	9.5015	9.5245	0.4985	9.5235	9.5491	0.4765	9.5443	9.5727	0.4557	9.5641	9.5954	0.4359	30
31	5019	5249	4981	5239	5496	4761	5447	5731	4553	5644	5958	4356	31
32	5022	5254	4978	5242	5500	4758	5450	5735	4550	5647	5961	4353	32
33	5026	5258	4974	5246	5504	4754	5453	5739	4547	5650	5965	4350	33
34	5030	5262	4970	5249	5508	4751	5457	5743	4543	5654	5969	4346	34
35	5034	5266	4966	5253	5512	4747	5460	5747	4540	5657	5972	4343	35
36	5037	5270	4963	5256	5516	4744	5463	5750	4537	5660	5976	4340	36
37	5041	5275	4959	5260	5520	4740	5467	5754	4533	5663	5980	4337	37
38	5045	5279	4955	5263	5524	4737	5470	5758	4530	5666	5984	4334	38
39	5049	5283	4951	5267	5528	4733	5474	5762	4526	5670	5987	4330	39
40	9.5052	9.5287	0.4948	9.5270	9.5531	0.4730	9.5477	9.5766	0.4523	9.5673	9.5991	0.4327	40
41	5056	5291	4946	5274	5535	4726	5480	5770	4520	5676	5995	4324	41
42	5060	5295	4940	5278	5539	4722	5484	5773	4516	5679	5998	4321	42
43	5064	5300	4936	5281	5543	4719	5487	5777	4513	5682	6002	4318	43
44	5067	5304	4933	5285	5547	4715	5490	5781	4510	5685	6006	4315	44
45	5071	5308	4929	5288	5551	4712	5494	5785	4506	5689	6009	4311	45
46	5075	5312	4925	5292	5555	4708	5497	5789	4503	5692	6013	4308	46
47	5078	5316	4922	5295	5559	4705	5500	5792	4500	5695	6017	4305	47
48	5082	5320	4918	5299	5563	4701	5504	5796	4496	5698	6020	4302	48
49	5086	5324	4914	5302	5567	4698	5507	5800	4493	5701	6024	4299	49
50	9.5090	9.5329	0.4910	9.5306	9.5571	0.4694	9.5510	9.5804	0.4490	9.5704	9.6028	0.4296	50
51	5093	5333	4907	5309	5575	4691	5514	5808	4486	5708	6031	4292	51
52	5097	5337	4903	5313	5579	4687	5517	5811	4483	5711	6035	4289	52
53	5101	5341	4899	5316	5583	4684	5520	5815	4480	5714	6039	4286	53
54	5104	5345	4896	5320	5587	4680	5523	5819	4477	5717	6042	4283	54
55	5108	5349	4892	5323	5591	4677	5527	5823	4473	5720	6046	4280	55
56	5112	5353	4888	5327	5595	4673	5530	5827	4470	5723	6050	4277	56
57	5115	5357	4885	5330	5599	4670	5533	5830	4467	5726	6053	4274	57
58	5119	5362	4881	5334	5603	4666	5537	5834	4463	5730	6057	4270	58
59	5123	5366	4877	5337	5607	4663	5540	5838	4460	5733	6060	4267	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	22 Degrees.			23 Degrees.			24 Degrees.			25 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.5736	9.6064	0.4264	9.5919	9.6279	0.4081	9.6093	9.6486	0.3907	9.6259	9.6687	0.3741	0
1	5739	6068	4261	5922	6282	4078	6096	6489	3904	6262	6690	3738	1
2	5742	6071	4258	5925	6286	4075	6099	6493	3901	6265	6692	3735	2
3	5745	6075	4255	5928	6289	4072	6102	6496	3898	6268	6697	3732	3
4	5748	6079	4252	5931	6293	4069	6104	6499	3896	6270	6700	3730	4
5	5751	6082	4249	5934	6296	4066	6107	6503	3893	6273	6703	3727	5
6	5754	6086	4246	5937	6300	4063	6110	6506	3890	6276	6706	3724	6
7	5758	6090	4242	5940	6303	4060	6113	6510	3887	6278	6710	3722	7
8	5761	6093	4239	5943	6307	4057	6116	6513	3884	6281	6713	3719	8
9	5764	6097	4236	5945	6310	4055	6119	6516	3881	6284	6716	3716	9
10	9.5767	9.6100	0.4233	9.5948	9.6314	0.4051	9.6121	9.6520	0.3879	9.6286	9.6720	0.3714	10
11	5770	6104	4230	5951	6317	4049	6124	6523	3876	6289	6723	3711	11
12	5773	6108	4227	5954	6321	4046	6127	6527	3873	6292	6726	3708	12
13	5776	6111	4224	5957	6324	4043	6130	6530	3870	6295	6729	3705	13
14	5779	6115	4221	5960	6328	4040	6133	6533	3867	6297	6733	3703	14
15	5782	6118	4218	5963	6331	4037	6135	6537	3865	6300	6736	3700	15
16	5785	6122	4215	5966	6334	4034	6138	6540	3862	6303	6739	3697	16
17	5789	6126	4211	5969	6338	4031	6141	6543	3859	6305	6743	3695	17
18	5792	6129	4208	5972	6341	4028	6144	6547	3856	6308	6746	3692	18
19	5795	6133	4205	5975	6345	4025	6147	6550	3853	6311	6749	3689	19
20	9.5798	9.6136	0.4202	9.5978	9.6348	0.4022	9.6149	9.6553	0.3851	9.6313	9.6752	0.3687	20
21	5801	6140	4199	5981	6352	4019	6152	6557	3848	6316	6756	3684	21
22	5804	6144	4196	5984	6355	4016	6155	6560	3845	6319	6759	3681	22
23	5807	6147	4193	5987	6359	4013	6158	6564	3842	6321	6762	3679	23
24	5810	6151	4190	5990	6362	4010	6161	6567	3839	6324	6765	3676	24
25	5813	6154	4187	5992	6366	4008	6163	6570	3837	6327	6769	3673	25
26	5816	6158	4184	5995	6369	4005	6166	6574	3834	6329	6772	3671	26
27	5819	6162	4181	5998	6373	4002	6169	6577	3831	6332	6775	3668	27
28	5822	6165	4178	6001	6376	3999	6172	6580	3828	6335	6778	3665	28
29	5825	6169	4175	6004	6380	3996	6175	6584	3825	6337	6782	3663	29
30	9.5828	9.6172	0.4172	9.6007	9.6383	0.3993	9.6177	9.6587	0.3823	9.6340	9.6785	0.3660	30
31	5831	6176	4169	6010	6386	3990	6180	6590	3820	6342	6788	3658	31
32	5834	6179	4166	6013	6390	3987	6183	6594	3817	6345	6791	3655	32
33	5838	6183	4162	6016	6393	3984	6186	6597	3814	6348	6795	3652	33
34	5841	6187	4159	6019	6397	3981	6188	6600	3812	6350	6798	3650	34
35	5844	6190	4156	6022	6400	3978	6191	6604	3809	6353	6801	3647	35
36	5847	6194	4153	6024	6404	3976	6194	6607	3806	6356	6804	3644	36
37	5850	6197	4150	6027	6407	3973	6197	6610	3803	6358	6808	3642	37
38	5853	6201	4147	6030	6411	3970	6199	6614	3801	6361	6811	3639	38
39	5856	6204	4144	6033	6414	3967	6202	6617	3798	6364	6814	3636	39
40	9.5859	9.6208	0.4141	9.6036	9.6417	0.3964	9.6205	9.6620	0.3795	9.6366	9.6817	0.3634	40
41	5862	6211	4138	6039	6421	3961	6208	6624	3792	6369	6821	3631	41
42	5865	6215	4135	6042	6424	3958	6210	6627	3790	6371	6824	3629	42
43	5868	6219	4132	6045	6428	3955	6213	6630	3787	6374	6827	3626	43
44	5871	6222	4129	6047	6431	3953	6216	6634	3784	6377	6830	3623	44
45	5874	6226	4126	6050	6435	3950	6219	6637	3781	6379	6834	3621	45
46	5877	6229	4123	6053	6438	3947	6221	6640	3779	6382	6837	3618	46
47	5880	6233	4120	6056	6441	3944	6224	6644	3776	6385	6840	3615	47
48	5883	6236	4117	6059	6445	3941	6227	6647	3773	6387	6843	3613	48
49	5886	6240	4114	6062	6448	3938	6230	6650	3770	6390	6846	3610	49
50	9.5889	9.6243	0.4111	9.6065	9.6452	0.3935	9.6232	9.6654	0.3768	9.6392	9.6850	0.3608	50
51	5892	6247	4108	6068	6455	3932	6235	6657	3765	6395	6853	3605	51
52	5895	6250	4105	6070	6459	3930	6238	6660	3762	6398	6856	3602	52
53	5898	6254	4102	6073	6462	3927	6240	6664	3760	6400	6859	3600	53
54	5901	6257	4099	6076	6465	3924	6243	6667	3757	6403	6863	3597	54
55	5904	6261	4096	6079	6469	3921	6246	6670	3754	6405	6866	3595	55
56	5907	6264	4093	6082	6472	3918	6249	6674	3751	6408	6869	3592	56
57	5910	6268	4090	6085	6476	3915	6251	6677	3749	6411	6872	3589	57
58	5913	6271	4087	6087	6479	3913	6254	6680	3746	6413	6875	3587	58
59	5916	6275	4084	6090	6482	3910	6257	6683	3743	6416	6879	3584	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	26 Degrees.			27 Degrees.			28 Degrees.			29 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.6418	9.6882	0.3582	9.6570	9.7072	0.3430	9.6716	9.7257	0.3284	9.6856	9.7438	0.3144	0
1	6421	6885	3579	6573	7075	3427	6718	7260	3282	6858	7441	3142	1
2	6424	6888	3576	6575	7078	3425	6721	7263	3279	6860	7443	3140	2
3	6426	6891	3574	6578	7081	3422	6723	7266	3277	6863	7446	3137	3
4	6429	6895	3571	6580	7084	3420	6726	7269	3274	6865	7449	3135	4
5	6431	6898	3569	6583	7087	3417	6728	7272	3272	6867	7452	3133	5
6	6434	6901	3566	6585	7090	3415	6730	7275	3270	6869	7455	3131	6
7	6437	6904	3563	6588	7093	3412	6733	7278	3267	6872	7458	3128	7
8	6439	6907	3561	6590	7097	3410	6735	7281	3265	6874	7461	3126	8
9	6442	6911	3558	6593	7100	3407	6737	7284	3263	6876	7464	3124	9
10	9.6444	9.6914	0.3556	9.6595	9.7103	0.3405	9.6740	9.7287	0.3260	9.6878	9.7467	0.3122	10
11	6447	6917	3553	6598	7106	3402	6742	7290	3258	6881	7470	3119	11
12	6449	6920	3551	6600	7109	3400	6744	7293	3256	6883	7473	3117	12
13	6452	6923	3548	6603	7112	3397	6747	7296	3253	6885	7476	3115	13
14	6455	6927	3545	6605	7115	3395	6749	7299	3251	6887	7479	3113	14
15	6457	6930	3543	6607	7118	3393	6752	7302	3248	6890	7482	3110	15
16	6460	6933	3540	6610	7121	3390	6754	7305	3246	6892	7485	3108	16
17	6462	6936	3538	6612	7125	3388	6756	7308	3244	6894	7488	3106	17
18	6465	6939	3535	6615	7128	3385	6759	7311	3241	6896	7491	3104	18
19	6467	6942	3533	6617	7131	3383	6761	7314	3239	6899	7494	3101	19
20	9.6470	9.6946	0.3530	9.6620	9.7134	0.3380	9.6763	9.7317	0.3237	9.6901	9.7497	0.3099	20
21	6472	6949	3528	6622	7137	3378	6766	7320	3234	6903	7500	3097	21
22	6475	6952	3525	6625	7140	3375	6768	7324	3232	6905	7503	3095	22
23	6477	6955	3523	6627	7143	3373	6770	7327	3230	6908	7506	3092	23
24	6480	6958	3520	6629	7146	3371	6773	7330	3227	6910	7509	3090	24
25	6483	6962	3517	6632	7149	3368	6775	7333	3225	6912	7512	3088	25
26	6485	6965	3515	6634	7152	3366	6777	7336	3223	6914	7515	3086	26
27	6488	6968	3512	6637	7156	3363	6780	7339	3220	6917	7518	3083	27
28	6490	6971	3510	6639	7159	3361	6782	7342	3218	6919	7521	3081	28
29	6493	6974	3507	6642	7162	3358	6784	7345	3216	6921	7523	3079	29
30	9.6495	9.6977	0.3505	9.6644	9.7165	0.3356	9.6787	9.7348	0.3213	9.6923	9.7526	0.3077	30
31	6498	6981	3502	6646	7168	3354	6789	7351	3211	6926	7529	3074	31
32	6500	6984	3500	6649	7171	3351	6791	7354	3209	6928	7532	3072	32
33	6503	6987	3497	6651	7174	3349	6794	7357	3206	6930	7535	3070	33
34	6505	6990	3495	6654	7177	3346	6796	7360	3204	6932	7538	3068	34
35	6508	6993	3492	6656	7180	3344	6798	7363	3202	6935	7541	3065	35
36	6510	6996	3490	6659	7183	3341	6801	7366	3199	6937	7544	3063	36
37	6513	6999	3487	6661	7186	3338	6803	7369	3197	6939	7547	3061	37
38	6515	7003	3485	6663	7189	3337	6805	7372	3195	6941	7550	3059	38
39	6518	7006	3482	6666	7192	3334	6808	7375	3192	6943	7553	3057	39
40	9.6521	9.7009	0.3479	9.6668	9.7196	0.3332	9.6810	9.7378	0.3190	9.6946	9.7556	0.3054	40
41	6523	7012	3477	6671	7199	3329	6812	7381	3188	6948	7559	3052	41
42	6526	7015	3474	6673	7202	3327	6814	7384	3186	6950	7562	3050	42
43	6528	7018	3472	6675	7205	3325	6817	7387	3183	6952	7565	3048	43
44	6531	7022	3469	6678	7208	3322	6819	7390	3181	6955	7568	3045	44
45	6533	7025	3467	6680	7211	3320	6821	7393	3179	6957	7571	3043	45
46	6536	7028	3464	6683	7214	3317	6824	7396	3176	6959	7573	3041	46
47	6538	7031	3462	6685	7217	3315	6826	7399	3174	6961	7576	3039	47
48	6541	7034	3459	6687	7220	3313	6828	7402	3172	6963	7579	3037	48
49	6543	7037	3457	6690	7223	3310	6831	7405	3169	6966	7582	3034	49
50	9.6546	9.7040	0.3454	9.6692	9.7226	0.3308	9.6833	9.7408	0.3167	9.6968	9.7585	0.3032	50
51	6548	7044	3452	6695	7229	3305	6835	7411	3165	6970	7588	3030	51
52	6551	7047	3449	6697	7232	3303	6837	7414	3163	6972	7591	3028	52
53	6553	7050	3447	6699	7235	3301	6840	7417	3160	6974	7594	3026	53
54	6556	7053	3444	6702	7238	3298	6842	7420	3158	6977	7597	3023	54
55	6558	7056	3442	6704	7241	3296	6844	7423	3156	6979	7600	3021	55
56	6561	7059	3439	6707	7245	3293	6847	7426	3153	6981	7603	3019	56
57	6563	7062	3437	6709	7248	3291	6849	7429	3151	6983	7606	3017	57
58	6566	7065	3434	6711	7251	3289	6851	7432	3149	6985	7609	3015	58
59	6568	7069	3432	6714	7254	3286	6853	7435	3147	6988	7611	3012	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	30 Degrees.			31 Degrees.			32 Degrees.			33 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.6990	9.7614	0.3010	9.7118	9.7788	0.2882	9.7242	9.7958	0.2758	9.7361	9.8125	0.2639	0
1	6992	7617	3008	7121	7791	2879	7244	7961	2756	7363	8128	2637	1
2	6994	7620	3006	7123	7793	2877	7246	7964	2754	7365	8131	2635	2
3	6996	7623	3004	7125	7796	2875	7248	7966	2752	7367	8133	2633	3
4	6998	7626	3002	7127	7799	2873	7250	7969	2750	7369	8136	2631	4
5	7001	7629	2999	7129	7802	2871	7252	7972	2748	7371	8139	2629	5
6	7003	7632	2997	7131	7805	2869	7254	7975	2746	7373	8142	2627	6
7	7005	7635	2995	7133	7808	2867	7256	7978	2744	7375	8145	2625	7
8	7007	7638	2993	7135	7811	2865	7258	7980	2742	7377	8147	2623	8
9	7009	7641	2991	7137	7813	2863	7260	7983	2740	7379	8150	2621	9
10	9.7012	9.7644	0.2988	9.7139	9.7816	0.2861	9.7262	9.7986	0.2738	9.7380	9.8153	0.2620	10
11	7014	7646	2986	7141	7819	2859	7264	7989	2736	7382	8156	2618	11
12	7016	7649	2984	7144	7822	2856	7266	7992	2734	7384	8158	2616	12
13	7018	7652	2982	7145	7825	2855	7268	7994	2732	7386	8161	2614	13
14	7020	7655	2980	7148	7828	2852	7270	7997	2730	7388	8164	2612	14
15	7022	7658	2978	7150	7831	2850	7272	8000	2728	7390	8167	2610	15
16	7025	7661	2975	7152	7833	2848	7274	8003	2726	7392	8169	2608	16
17	7027	7664	2973	7154	7836	2846	7276	8006	2724	7394	8172	2606	17
18	7029	7667	2971	7156	7839	2844	7278	8008	2722	7396	8175	2604	18
19	7031	7670	2969	7158	7842	2842	7280	8011	2720	7398	8178	2602	19
20	9.7033	9.7673	0.2967	9.7160	9.7845	0.2840	9.7282	9.8014	0.2718	9.7400	9.8180	0.2600	20
21	7035	7675	2965	7162	7848	2838	7284	8017	2716	7402	8183	2598	21
22	7037	7678	2963	7164	7850	2836	7286	8020	2714	7404	8186	2596	22
23	7040	7681	2960	7166	7853	2834	7288	8022	2712	7406	8189	2594	23
24	7042	7684	2958	7168	7856	2832	7290	8025	2710	7407	8191	2593	24
25	7044	7687	2956	7171	7859	2829	7292	8028	2708	7409	8194	2591	25
26	7046	7690	2954	7173	7862	2827	7294	8031	2706	7411	8197	2589	26
27	7048	7693	2952	7175	7865	2825	7296	8034	2704	7413	8200	2587	27
28	7050	7696	2950	7177	7868	2823	7298	8036	2702	7415	8202	2585	28
29	7053	7699	2947	7179	7870	2821	7300	8039	2700	7417	8205	2583	29
30	9.7055	9.7701	0.2945	9.7181	9.7873	0.2819	9.7302	9.8042	0.2698	9.7419	9.8208	0.2581	30
31	7057	7704	2943	7183	7876	2817	7304	8045	2696	7421	8211	2579	31
32	7059	7707	2941	7185	7879	2815	7306	8047	2694	7423	8213	2577	32
33	7061	7710	2939	7187	7882	2813	7308	8050	2692	7425	8216	2575	33
34	7063	7713	2937	7189	7885	2811	7310	8053	2690	7427	8219	2573	34
35	7065	7716	2935	7191	7887	2809	7312	8056	2688	7428	8222	2572	35
36	7068	7719	2932	7193	7890	2807	7314	8059	2686	7430	8224	2570	36
37	7070	7722	2930	7195	7893	2805	7316	8061	2684	7432	8227	2568	37
38	7072	7725	2928	7197	7896	2803	7318	8064	2682	7434	8230	2566	38
39	7074	7727	2926	7199	7899	2801	7320	8067	2680	7436	8233	2564	39
40	9.7076	9.7730	0.2924	9.7201	9.7902	0.2799	9.7322	9.8070	0.2678	9.7438	9.8235	0.2562	40
41	7078	7733	2922	7203	7904	2797	7324	8072	2676	7440	8238	2560	41
42	7080	7736	2920	7205	7907	2795	7326	8075	2674	7442	8241	2558	42
43	7082	7739	2918	7208	7910	2792	7328	8078	2672	7444	8243	2556	43
44	7085	7742	2915	7210	7913	2790	7330	8081	2670	7446	8246	2554	44
45	7087	7745	2913	7212	7916	2788	7332	8084	2668	7447	8249	2553	45
46	7089	7748	2911	7214	7918	2786	7334	8086	2666	7449	8252	2551	46
47	7091	7750	2909	7216	7921	2784	7336	8089	2664	7451	8254	2549	47
48	7093	7753	2907	7218	7924	2782	7338	8092	2662	7453	8257	2547	48
49	7095	7756	2905	7220	7927	2780	7340	8095	2660	7455	8260	2545	49
50	9.7097	9.7759	0.2903	9.7222	9.7930	0.2778	9.7342	9.8097	0.2658	9.7457	9.8263	0.2543	50
51	7099	7762	2901	7224	7933	2776	7344	8100	2656	7459	8265	2541	51
52	7102	7765	2898	7226	7935	2774	7345	8103	2655	7461	8268	2539	52
53	7104	7768	2896	7228	7938	2772	7347	8106	2653	7462	8271	2538	53
54	7106	7771	2894	7230	7941	2770	7349	8109	2651	7464	8274	2536	54
55	7108	7773	2892	7232	7944	2768	7351	8111	2649	7466	8276	2534	55
56	7110	7776	2890	7234	7947	2766	7353	8114	2647	7468	8279	2532	56
57	7112	7779	2888	7236	7949	2764	7355	8117	2645	7470	8282	2530	57
58	7114	7782	2886	7238	7952	2762	7357	8120	2643	7472	8284	2528	58
59	7116	7785	2884	7240	7955	2760	7359	8122	2641	7474	8287	2526	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	34 Degrees.			35 Degrees.			36 Degrees.			37 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.7476	9.8290	0.2524	9.7586	9.8452	0.2414	9.7692	9.8613	0.2308	9.7795	9.8771	0.2205	0
1	7477	8293	2523	7588	8455	2412	7694	8615	2306	7796	8774	2204	1
2	7479	8295	2521	7590	8458	2410	7696	8618	2304	7798	8776	2202	2
3	7481	8298	2519	7591	8460	2409	7697	8621	2303	7800	8779	2200	3
4	7483	8301	2517	7593	8463	2407	7699	8623	2301	7801	8782	2199	4
5	7485	8303	2515	7595	8466	2405	7701	8626	2299	7803	8784	2197	5
6	7487	8306	2513	7597	8468	2403	7703	8629	2297	7805	8787	2195	6
7	7489	8309	2511	7599	8471	2401	7704	8631	2296	7806	8790	2194	7
8	7491	8312	2509	7600	8474	2400	7706	8634	2294	7808	8792	2192	8
9	7492	8314	2508	7602	8476	2398	7708	8637	2292	7810	8795	2190	9
10	9.7494	9.8317	0.2506	9.7604	9.8479	0.2396	9.7710	9.8639	0.2290	9.7811	9.8797	0.2189	10
11	7496	8320	2504	7606	8482	2394	7711	8642	2289	7813	8800	2187	11
12	7498	8323	2502	7607	8484	2393	7713	8644	2287	7815	8803	2185	12
13	7500	8325	2500	7609	8487	2391	7715	8647	2285	7816	8805	2184	13
14	7502	8328	2498	7611	8490	2389	7716	8650	2284	7818	8808	2182	14
15	7504	8331	2496	7613	8493	2387	7718	8652	2282	7820	8810	2180	15
16	7505	8333	2495	7615	8495	2385	7720	8655	2280	7821	8813	2179	16
17	7507	8336	2493	7616	8498	2384	7722	8658	2278	7823	8816	2177	17
18	7509	8339	2491	7618	8501	2382	7723	8660	2277	7825	8818	2175	18
19	7511	8342	2489	7620	8503	2380	7725	8663	2275	7826	8821	2174	19
20	9.7513	9.8344	0.2487	9.7622	9.8506	0.2378	9.7727	9.8666	0.2273	9.7828	9.8824	0.2172	20
21	7515	8347	2485	7624	8509	2376	7728	8668	2272	7830	8826	2170	21
22	7517	8350	2483	7625	8511	2375	7730	8671	2270	7831	8829	2169	22
23	7518	8352	2482	7627	8514	2373	7732	8674	2268	7833	8831	2167	23
24	7520	8355	2480	7629	8517	2371	7734	8676	2266	7835	8834	2165	24
25	7522	8358	2478	7631	8519	2369	7735	8679	2265	7836	8837	2164	25
26	7524	8361	2476	7632	8522	2368	7737	8682	2263	7838	8839	2162	26
27	7526	8363	2474	7634	8525	2366	7739	8684	2261	7840	8842	2160	27
28	7528	8366	2472	7636	8527	2364	7740	8687	2260	7841	8845	2159	28
29	7529	8369	2471	7638	8530	2362	7742	8689	2258	7843	8847	2157	29
30	9.7531	9.8371	0.2469	9.7640	9.8533	0.2360	9.7744	9.8692	0.2256	9.7844	9.8850	0.2156	30
31	7533	8374	2467	7641	8535	2359	7746	8695	2254	7846	8852	2154	31
32	7535	8377	2465	7643	8538	2357	7747	8697	2253	7848	8855	2152	32
33	7537	8379	2463	7645	8541	2355	7749	8700	2251	7849	8858	2151	33
34	7539	8382	2461	7647	8543	2353	7751	8703	2249	7851	8860	2149	34
35	7540	8385	2460	7648	8546	2352	7752	8705	2248	7853	8863	2147	35
36	7542	8388	2458	7650	8549	2350	7754	8708	2246	7854	8865	2146	36
37	7544	8390	2456	7652	8551	2348	7756	8711	2244	7856	8868	2144	37
38	7546	8393	2454	7654	8554	2346	7758	8713	2242	7858	8871	2142	38
39	7548	8396	2452	7655	8557	2345	7759	8716	2241	7859	8873	2140	39
40	9.7550	9.8398	0.2450	9.7657	9.8559	0.2343	9.7761	9.8718	0.2239	9.7861	9.8876	0.2139	40
41	7551	8401	2449	7659	8562	2341	7763	8721	2237	7863	8879	2137	41
42	7553	8404	2447	7661	8565	2339	7764	8724	2236	7864	8881	2136	42
43	7555	8406	2445	7662	8567	2338	7766	8726	2234	7866	8884	2134	43
44	7557	8409	2443	7664	8570	2336	7768	8729	2232	7867	8886	2133	44
45	7559	8412	2441	7666	8573	2334	7769	8732	2231	7869	8889	2131	45
46	7561	8415	2439	7668	8575	2332	7771	8734	2229	7871	8892	2129	46
47	7562	8417	2438	7669	8578	2331	7773	8737	2227	7872	8894	2128	47
48	7564	8420	2436	7671	8581	2329	7774	8740	2226	7874	8897	2126	48
49	7566	8423	2434	7673	8583	2327	7776	8742	2224	7876	8899	2124	49
50	9.7568	9.8425	0.2432	9.7675	9.8586	0.2325	9.7778	9.8745	0.2222	9.7877	9.8902	0.2123	50
51	7570	8428	2430	7676	8589	2324	7780	8747	2220	7879	8905	2121	51
52	7571	8431	2429	7678	8591	2322	7781	8750	2219	7880	8907	2120	52
53	7573	8433	2427	7680	8594	2320	7783	8753	2217	7882	8910	2118	53
54	7575	8436	2425	7682	8597	2318	7785	8755	2215	7884	8912	2116	54
55	7577	8439	2423	7683	8599	2317	7786	8758	2214	7885	8915	2115	55
56	7579	8442	2421	7685	8602	2315	7788	8761	2212	7887	8918	2113	56
57	7581	8444	2419	7687	8605	2313	7790	8763	2210	7889	8920	2111	57
58	7582	8447	2418	7689	8607	2311	7791	8766	2209	7890	8923	2110	58
59	7584	8450	2416	7690	8610	2310	7793	8769	2207	7892	8925	2108	59

Logarithmic Sines, Tangents, and Cosecants.

M.	38 Degrees.			39 Degrees.			40 Degrees.			41 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.7893	9.8928	0.2107	9.7989	9.9084	0.2011	9.8081	9.9238	0.1919	9.8169	9.9392	0.1831	0
1	7895	8931	2105	7990	9086	2010	8082	9241	1918	8171	9394	1829	1
2	7897	8933	2103	7992	9089	2008	8084	9243	1916	8172	9397	1828	2
3	7898	8936	2102	7993	9091	2007	8085	9246	1915	8174	9399	1826	3
4	7900	8939	2100	7995	9094	2005	8087	9248	1913	8175	9402	1825	4
5	7901	8941	2099	7997	9097	2003	8088	9251	1912	8177	9404	1823	5
6	7903	8944	2097	7998	9099	2002	8090	9254	1910	8178	9407	1822	6
7	7905	8946	2095	8000	9102	2000	8091	9256	1909	8180	9409	1820	7
8	7906	8949	2094	8001	9104	1999	8093	9259	1907	8181	9412	1819	8
9	7908	8952	2092	8003	9107	1997	8094	9261	1906	8182	9415	1818	9
10	9.7910	9.8954	0.2090	9.8004	9.9110	0.1996	9.8096	9.9264	0.1904	9.8184	9.9417	0.1816	10
11	7911	8957	2089	8006	9112	1994	8097	9266	1903	8185	9420	1815	11
12	7913	8959	2087	8007	9115	1993	8099	9269	1901	8187	9422	1813	12
13	7914	8962	2086	8009	9117	1991	8100	9271	1900	8188	9425	1812	13
14	7916	8965	2084	8010	9120	1990	8102	9274	1898	8190	9427	1810	14
15	7918	8967	2082	8012	9122	1988	8103	9277	1897	8191	9430	1809	15
16	7919	8970	2081	8014	9125	1986	8105	9279	1895	8193	9432	1807	16
17	7921	8972	2079	8015	9128	1985	8106	9282	1894	8194	9435	1806	17
18	7922	8975	2078	8017	9130	1983	8108	9284	1892	8195	9438	1805	18
19	7924	8978	2076	8018	9133	1982	8109	9287	1891	8197	9440	1803	19
20	9.7926	9.8980	0.2074	9.8020	9.9135	0.1980	9.8111	9.9289	0.1889	9.8198	9.9443	0.1802	20
21	7927	8983	2073	8021	9138	1979	8112	9292	1888	8200	9445	1800	21
22	7929	8985	2071	8023	9140	1977	8114	9295	1886	8201	9448	1799	22
23	7930	8988	2070	8024	9143	1976	8115	9297	1885	8203	9450	1797	23
24	7932	8990	2068	8026	9146	1974	8117	9300	1883	8204	9453	1796	24
25	7934	8993	2066	8027	9148	1973	8118	9302	1882	8206	9455	1794	25
26	7935	8996	2065	8029	9151	1971	8120	9305	1880	8207	9458	1793	26
27	7937	8998	2063	8031	9153	1969	8121	9307	1879	8208	9460	1792	27
28	7938	9001	2062	8032	9156	1968	8122	9310	1878	8210	9463	1790	28
29	7940	9003	2060	8034	9158	1966	8124	9312	1876	8211	9466	1789	29
30	9.7942	9.9006	0.2058	9.8035	9.9161	0.1965	9.8125	9.9315	0.1875	9.8213	9.9468	0.1787	30
31	7943	9009	2057	8037	9164	1963	8127	9318	1873	8214	9471	1786	31
32	7945	9011	2055	8038	9166	1962	8128	9320	1872	8216	9473	1784	32
33	7946	9014	2054	8040	9169	1960	8130	9323	1870	8217	9476	1783	33
34	7948	9016	2052	8041	9171	1959	8131	9325	1869	8218	9478	1782	34
35	7949	9019	2051	8043	9174	1957	8133	9328	1867	8220	9481	1780	35
36	7951	9022	2049	8044	9176	1956	8134	9330	1866	8221	9483	1779	36
37	7953	9024	2047	8046	9179	1954	8136	9333	1864	8223	9486	1777	37
38	7954	9027	2046	8047	9182	1953	8137	9335	1863	8224	9488	1776	38
39	7956	9029	2044	8049	9184	1951	8139	9338	1861	8225	9491	1775	39
40	9.7957	9.9032	0.2043	9.8050	9.9187	0.1950	9.8140	9.9341	0.1860	9.8227	9.9494	0.1773	40
41	7959	9035	2041	8052	9189	1948	8142	9343	1858	8228	9496	1772	41
42	7960	9037	2040	8053	9192	1947	8143	9346	1857	8230	9499	1770	42
43	7962	9040	2038	8055	9194	1945	8145	9348	1855	8231	9501	1769	43
44	7964	9042	2036	8056	9197	1944	8146	9351	1854	8233	9504	1767	44
45	7965	9045	2035	8058	9200	1942	8148	9353	1852	8234	9506	1766	45
46	7967	9048	2033	8060	9202	1940	8149	9356	1851	8235	9509	1765	46
47	7968	9050	2032	8061	9205	1939	8150	9358	1850	8237	9511	1763	47
48	7970	9053	2030	8063	9207	1937	8152	9361	1848	8238	9514	1762	48
49	7972	9055	2028	8064	9210	1936	8153	9364	1847	8240	9516	1760	49
50	9.7973	9.9058	0.2027	9.8066	9.9212	0.1934	9.8155	9.9366	0.1845	9.8241	9.9519	0.1759	50
51	7975	9060	2025	8067	9215	1933	8156	9369	1844	8242	9522	1758	51
52	7976	9063	2024	8069	9218	1931	8158	9371	1842	8244	9524	1756	52
53	7978	9066	2022	8070	9220	1930	8159	9374	1841	8245	9527	1755	53
54	7979	9068	2021	8072	9223	1928	8161	9376	1839	8247	9529	1753	54
55	7981	9071	2019	8073	9225	1927	8162	9379	1838	8248	9532	1752	55
56	7982	9073	2018	8075	9228	1925	8164	9381	1836	8249	9534	1751	56
57	7984	9076	2016	8076	9230	1924	8165	9384	1835	8251	9537	1749	57
58	7986	9079	2014	8078	9233	1922	8167	9387	1833	8252	9539	1748	58
59	7987	9081	2013	8079	9236	1921	8168	9389	1832	8254	9542	1746	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	42 Degrees.			43 Degrees.			44 Degrees.			45 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.8255	9.9544	0.1745	9.8338	9.9697	0.1662	9.8418	9.9848	0.1582	9.8495	0.0000	0.1505	0
1	8257	9547	1743	8339	9699	1661	8419	9851	1581	8496	0002	1504	1
2	8258	9549	1742	8341	9702	1659	8420	9853	1580	8497	0005	1503	2
3	8259	9552	1741	8342	9704	1658	8422	9856	1578	8499	0008	1501	3
4	8261	9555	1739	8343	9707	1657	8423	9858	1577	8500	0010	1500	4
5	8262	9557	1738	8345	9709	1655	8424	9861	1576	8501	0013	1499	5
6	8264	9560	1736	8346	9712	1654	8426	9864	1574	8502	0015	1498	6
7	8265	9562	1735	8347	9714	1653	8427	9866	1573	8504	0018	1496	7
8	8236	9565	1734	8349	9717	1651	8428	9869	1572	8505	0020	1495	8
9	8268	9567	1732	8350	9719	1650	8429	9871	1571	8506	0023	1494	9
10	9.8269	9.9570	0.1731	9.8351	9.9722	0.1649	9.8431	9.9874	0.1569	9.8507	0.0025	0.1493	10
11	8270	9572	1730	8353	9724	1647	8432	9876	1568	8509	0028	1491	11
12	8272	9575	1728	8354	9727	1646	8433	9879	1567	8510	0030	1490	12
13	8273	9577	1727	8355	9729	1645	8435	9881	1565	8511	0033	1489	13
14	8275	9580	1725	8357	9732	1643	8436	9884	1564	8512	0035	1488	14
15	8276	9582	1724	8358	9735	1642	8437	9886	1563	8514	0038	1486	15
16	8277	9585	1723	8359	9737	1641	8439	9889	1561	8515	0040	1485	16
17	8279	9588	1721	8361	9740	1639	8440	9891	1560	8516	0043	1484	17
18	8280	9590	1720	8362	9742	1638	8441	9894	1559	8517	0045	1483	18
19	8282	9593	1718	8363	9745	1637	8442	9896	1558	8519	0048	1481	19
20	9.8283	9.9595	0.1717	9.8365	9.9747	0.1635	9.8444	9.9899	0.1556	9.8520	0.0051	0.1480	20
21	8284	9598	1716	8366	9750	1634	8445	9901	1555	8521	0053	1479	21
22	8286	9600	1714	8367	9752	1633	8446	9904	1554	8522	0056	1478	22
23	8287	9603	1713	8369	9755	1631	8448	9907	1552	8524	0058	1476	23
24	8289	9605	1711	8370	9757	1630	8449	9909	1551	8525	0061	1475	24
25	8290	9608	1710	8371	9760	1629	8450	9912	1550	8526	0063	1474	25
26	8291	9610	1709	8373	9762	1627	8451	9914	1549	8527	0066	1473	26
27	8293	9613	1707	8374	9765	1626	8453	9917	1547	8529	0068	1471	27
28	8294	9615	1706	8375	9767	1625	8454	9919	1546	8530	0071	1470	28
29	8295	9618	1705	8377	9770	1623	8455	9922	1545	8531	0073	1469	29
30	9.8297	9.9621	0.1703	9.8378	9.9773	0.1622	9.8457	9.9924	0.1543	9.8532	0.0076	0.1468	30
31	8298	9623	1702	8379	9775	1621	8458	9927	1542	8534	0078	1466	31
32	8300	9626	1700	8381	9778	1619	8459	9929	1541	8535	0081	1465	32
33	8301	9628	1699	8382	9780	1618	8460	9932	1540	8536	0083	1464	33
34	8302	9631	1698	8383	9783	1617	8462	9934	1538	8537	0086	1463	34
35	8304	9633	1696	8385	9785	1615	8463	9937	1537	8539	0088	1461	35
36	8305	9636	1695	8386	9788	1614	8464	9939	1536	8540	0091	1460	36
37	8306	9638	1694	8387	9790	1613	8466	9942	1534	8541	0093	1459	37
38	8308	9641	1692	8389	9793	1611	8467	9944	1533	8542	0096	1458	38
39	8309	9643	1691	8390	9795	1610	8468	9947	1532	8544	0099	1456	39
40	9.8311	9.9646	0.1689	9.8391	9.9798	0.1609	9.8469	9.9949	0.1531	9.8545	0.0101	0.1455	40
41	8312	9648	1688	8393	9800	1607	8471	9952	1529	8546	0104	1454	41
42	8313	9651	1687	8394	9803	1606	8472	9955	1528	8547	0106	1453	42
43	8315	9653	1685	8395	9805	1605	8473	9957	1527	8549	0109	1451	43
44	8316	9656	1684	8397	9808	1603	8475	9960	1525	8550	0111	1450	44
45	8317	9659	1683	8398	9810	1602	8476	9962	1524	8551	0114	1449	45
46	8319	9661	1681	8399	9813	1601	8477	9965	1523	8552	0116	1448	46
47	8320	9664	1680	8401	9816	1599	8478	9967	1522	8553	0119	1447	47
48	8322	9666	1678	8402	9818	1598	8480	9970	1520	8555	0121	1445	48
49	8323	9669	1677	8403	9821	1597	8481	9972	1519	8556	0124	1444	49
50	9.8324	9.9671	0.1676	9.8405	9.9823	0.1595	9.8482	9.9975	0.1518	9.8557	0.0126	0.1443	50
51	8326	9674	1674	8406	9826	1594	8483	9977	1517	8558	0129	1442	51
52	8327	9676	1673	8407	9828	1593	8485	9980	1515	8560	0131	1440	52
53	8328	9679	1672	8409	9831	1591	8486	9982	1514	8561	0134	1439	53
54	8330	9681	1670	8410	9833	1590	8487	9985	1513	8562	0136	1438	54
55	8331	9684	1669	8411	9836	1589	8489	9987	1511	8563	0139	1437	55
56	8332	9686	1668	8412	9838	1588	8490	9990	1510	8564	0142	1436	56
57	8334	9689	1666	8414	9841	1586	8491	9992	1509	8566	0144	1434	57
58	8335	9691	1665	8415	9843	1585	8492	9995	1508	8567	0147	1433	58
59	8336	9694	1664	8416	9846	1584	8494	9997	1506	8568	0149	1432	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	46 Degrees.			47 Degrees.			48 Degrees.			49 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.8569	0.0152	0.1431	9.8641	0.0303	0.1359	9.8711	0.0456	0.1289	9.8778	0.0608	0.1222	0
1	8571	0154	1429	8642	0306	1358	8712	0458	1288	8779	0611	1221	1
2	8572	0157	1428	8644	0309	1356	8713	0461	1287	8780	0613	1220	2
3	8573	0159	1427	8645	0311	1355	8714	0463	1286	8781	0616	1219	3
4	8574	0162	1426	8646	0314	1354	8715	0466	1285	8782	0619	1218	4
5	8575	0164	1425	8647	0316	1353	8716	0468	1284	8783	0621	1217	5
6	8577	0167	1423	8648	0319	1352	8718	0471	1282	8784	0624	1216	6
7	8578	0169	1422	8650	0321	1350	8719	0473	1281	8785	0626	1215	7
8	8579	0172	1421	8651	0324	1349	8720	0476	1280	8787	0629	1213	8
9	8580	0174	1420	8652	0326	1348	8721	0479	1279	8788	0631	1212	9
10	9.8582	0.0176	0.1418	9.8653	0.0329	0.1347	9.8722	0.0481	0.1278	9.8789	0.0634	0.1211	10
11	8583	0179	1417	8654	0331	1346	8723	0484	1277	8790	0636	1210	11
12	8584	0182	1416	8655	0334	1345	8724	0486	1276	8791	0639	1209	12
13	8585	0185	1415	8657	0336	1343	8725	0489	1275	8792	0642	1208	13
14	8586	0187	1414	8658	0339	1342	8727	0491	1273	8793	0644	1207	14
15	8588	0190	1412	8659	0341	1341	8728	0494	1272	8794	0647	1206	15
16	8589	0192	1411	8660	0344	1340	8729	0496	1271	8795	0649	1205	16
17	8590	0195	1410	8661	0347	1339	8730	0499	1270	8796	0652	1204	17
18	8591	0197	1409	8662	0349	1338	8731	0501	1269	8797	0654	1203	18
19	8592	0200	1408	8664	0352	1336	8732	0504	1268	8799	0657	1201	19
20	9.8594	0.0202	0.1406	9.8665	0.0354	0.1335	9.8733	0.0506	0.1267	9.8800	0.0659	0.1200	20
21	8595	0205	1405	8666	0357	1334	8734	0509	1266	8801	0662	1199	21
22	8596	0207	1404	8667	0359	1333	8736	0512	1264	8802	0665	1198	22
23	8597	0210	1403	8668	0362	1332	8737	0514	1263	8803	0667	1197	23
24	8598	0212	1402	8669	0364	1331	8738	0517	1262	8804	0670	1196	24
25	8600	0215	1400	8671	0367	1329	8739	0519	1261	8805	0672	1195	25
26	8601	0217	1399	8672	0369	1328	8740	0522	1260	8806	0675	1194	26
27	8602	0220	1398	8673	0372	1327	8741	0524	1259	8807	0677	1193	27
28	8603	0222	1397	8674	0374	1326	8742	0527	1258	8808	0680	1192	28
29	8604	0225	1396	8675	0377	1325	8743	0529	1257	8809	0682	1191	29
30	9.8606	0.0228	0.1394	9.8676	0.0379	0.1324	9.8745	0.0532	0.1255	9.8810	0.0685	0.1190	30
31	8607	0230	1393	8677	0382	1323	8746	0534	1254	8812	0688	1188	31
32	8608	0233	1392	8679	0385	1321	8747	0537	1253	8813	0690	1187	32
33	8609	0235	1391	8680	0387	1320	8748	0540	1252	8814	0693	1186	33
34	8610	0238	1390	8681	0390	1319	8749	0542	1251	8815	0695	1185	34
35	8612	0240	1388	8682	0392	1318	8750	0545	1250	8816	0698	1184	35
36	8613	0243	1387	8683	0395	1317	8751	0547	1249	8817	0700	1183	36
37	8614	0245	1386	8684	0397	1316	8752	0550	1248	8818	0703	1182	37
38	8615	0248	1385	8686	0400	1314	8753	0552	1247	8819	0705	1181	38
39	8616	0250	1384	8687	0402	1313	8755	0555	1245	8820	0708	1180	39
40	9.8618	0.0253	0.1382	9.8688	0.0405	0.1312	9.8756	0.0558	0.1244	9.8821	0.0711	0.1179	40
41	8619	0255	1381	8689	0407	1311	8757	0560	1243	8822	0713	1178	41
42	8620	0258	1380	8690	0410	1310	8758	0562	1242	8823	0716	1177	42
43	8621	0260	1379	8691	0412	1309	8759	0565	1241	8824	0718	1176	43
44	8622	0263	1378	8692	0415	1308	8760	0568	1240	8826	0721	1174	44
45	8624	0265	1376	8694	0418	1306	8761	0570	1239	8827	0723	1173	45
46	8625	0268	1375	8695	0420	1305	8762	0573	1238	8828	0726	1172	46
47	8626	0271	1374	8696	0423	1304	8763	0575	1237	8829	0729	1171	47
48	8627	0273	1373	8697	0425	1303	8765	0578	1235	8830	0731	1170	48
49	8628	0276	1372	8698	0428	1302	8766	0580	1234	8831	0734	1169	49
50	9.8629	0.0278	0.1371	9.8699	0.0430	0.1301	9.8767	0.0583	0.1233	9.8832	0.0736	0.1168	50
51	8631	0281	1369	8700	0433	1300	8768	0585	1232	8833	0739	1167	51
52	8632	0283	1368	8702	0435	1298	8769	0588	1231	8834	0741	1166	52
53	8633	0286	1367	8703	0438	1297	8770	0591	1230	8835	0744	1165	53
54	8634	0288	1366	8704	0440	1296	8771	0593	1229	8836	0746	1164	54
55	8635	0291	1365	8705	0443	1295	8772	0596	1228	8837	0749	1163	55
56	8637	0293	1363	8706	0445	1294	8773	0598	1227	8838	0752	1162	56
57	8638	0296	1362	8707	0448	1293	8775	0601	1225	8839	0754	1161	57
58	8639	0298	1361	8708	0451	1292	8776	0603	1224	8840	0757	1160	58
59	8640	0301	1360	8710	0453	1290	8777	0606	1223	8841	0759	1159	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	50 Degrees.			51 Degrees.			52 Degrees.			53 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.8843	0.0762	0.1157	9.8905	0.0916	0.1095	9.8965	0.1072	0.1035	9.9023	0.1229	0.0977	0
1	8844	0764	1156	8906	0919	1094	8966	1075	1034	9024	1231	0976	1
2	8845	0767	1155	8907	0921	1093	8967	1077	1033	9025	1234	0975	2
3	8846	0770	1154	8908	0924	1092	8968	1080	1032	9026	1237	0974	3
4	8847	0772	1153	8909	0927	1091	8969	1082	1031	9027	1239	0973	4
5	8848	0775	1152	8910	0929	1090	8970	1085	1030	9028	1242	0972	5
6	8849	0777	1151	8911	0932	1089	8971	1088	1029	9029	1245	0971	6
7	8850	0780	1150	8912	0934	1088	8972	1090	1028	9030	1247	0970	7
8	8851	0782	1149	8913	0937	1087	8973	1093	1027	9031	1250	0969	8
9	8852	0785	1148	8914	0940	1086	8974	1095	1026	9032	1253	0968	9
10	9.8853	0.0788	0.1147	9.8915	0.0942	0.1085	9.8975	0.1098	0.1025	9.9033	0.1255	0.0967	10
11	8854	0790	1146	8916	0945	1084	8976	1101	1024	9034	1258	0966	11
12	8855	0793	1145	8917	0947	1083	8977	1103	1023	9035	1260	0965	12
13	8856	0795	1144	8918	0950	1082	8978	1106	1022	9036	1263	0964	13
14	8857	0798	1143	8919	0953	1081	8979	1108	1021	9037	1266	0963	14
15	8858	0800	1142	8920	0955	1080	8980	1111	1020	9038	1268	0962	15
16	8859	0803	1141	8921	0958	1079	8981	1114	1019	9039	1271	0961	16
17	8860	0806	1140	8922	0960	1078	8982	1116	1018	9040	1274	0960	17
18	8862	0808	1138	8923	0963	1077	8983	1119	1017	9041	1276	0959	18
19	8863	0811	1137	8924	0965	1076	8984	1121	1016	9041	1279	0959	19
20	9.8864	0.0813	0.1136	9.8925	0.0968	0.1075	9.8985	0.1124	0.1015	9.9042	0.1282	0.0958	20
21	8865	0816	1135	8926	0971	1074	8986	1127	1014	9043	1284	0957	21
22	8866	0818	1134	8927	0973	1073	8987	1129	1013	9044	1287	0956	22
23	8867	0821	1133	8928	0976	1072	8988	1132	1012	9045	1289	0955	23
24	8868	0824	1132	8929	0978	1071	8989	1135	1011	9046	1292	0954	24
25	8869	0826	1131	8930	0981	1070	8990	1137	1010	9047	1295	0953	25
26	8870	0829	1130	8931	0984	1069	8991	1140	1009	9048	1297	0952	26
27	8871	0831	1129	8932	0986	1068	8992	1142	1008	9049	1300	0951	27
28	8872	0834	1128	8933	0989	1067	8993	1145	1007	9050	1303	0950	28
29	8873	0836	1127	8934	0991	1066	8994	1148	1006	9051	1305	0949	29
30	9.8874	0.0839	0.1126	9.8935	0.0994	0.1065	9.8995	0.1150	0.1005	9.9052	0.1308	0.0948	30
31	8875	0842	1125	8936	0997	1064	8996	1153	1004	9053	1311	0947	31
32	8876	0844	1124	8937	0999	1063	8997	1155	1003	9054	1313	0946	32
33	8877	0847	1123	8938	1002	1062	8998	1158	1002	9055	1316	0945	33
34	8878	0849	1122	8939	1004	1061	8999	1161	1001	9056	1318	0944	34
35	8879	0852	1121	8940	1007	1060	9000	1163	1000	9056	1321	0944	35
36	8880	0854	1120	8941	1010	1059	9000	1166	1000	9057	1324	0943	36
37	8881	0857	1119	8942	1012	1058	9001	1169	0999	9058	1326	0942	37
38	8882	0860	1118	8943	1015	1057	9002	1171	0998	9059	1329	0941	38
39	8883	0862	1117	8944	1017	1056	9003	1174	0997	9060	1332	0940	39
40	9.8884	0.0865	0.1116	9.8945	0.1020	0.1055	9.9004	0.1176	0.0996	9.9061	0.1334	0.0939	40
41	8885	0867	1115	8946	1022	1054	9005	1179	0995	9062	1337	0938	41
42	8887	0870	1113	8947	1025	1053	9006	1182	0994	9063	1340	0937	42
43	8888	0872	1112	8948	1028	1052	9007	1184	0993	9064	1342	0936	43
44	8889	0875	1111	8949	1030	1051	9008	1187	0992	9065	1345	0935	44
45	8890	0878	1110	8950	1033	1050	9009	1189	0991	9066	1348	0934	45
46	8891	0880	1109	8951	1035	1049	9010	1192	0990	9067	1350	0933	46
47	8892	0883	1108	8952	1038	1048	9011	1195	0989	9068	1353	0932	47
48	8893	0885	1107	8953	1041	1047	9012	1197	0988	9069	1356	0931	48
49	8894	0888	1106	8954	1043	1046	9013	1200	0987	9069	1358	0931	49
50	9.8895	0.0890	0.1105	9.8955	0.1046	0.1045	9.9014	0.1203	0.0986	9.9070	0.1361	0.0930	50
51	8896	0893	1104	8956	1048	1044	9015	1205	0985	9071	1364	0929	51
52	8897	0896	1103	8957	1051	1043	9016	1208	0984	9072	1366	0928	52
53	8898	0898	1102	8958	1054	1042	9017	1210	0983	9073	1369	0927	53
54	8899	0901	1101	8959	1056	1041	9018	1213	0982	9074	1371	0926	54
55	8900	0903	1100	8960	1059	1040	9019	1216	0981	9075	1374	0925	55
56	8901	0906	1099	8961	1061	1039	9020	1218	0980	9076	1377	0924	56
57	8902	0909	1098	8962	1064	1038	9021	1221	0979	9077	1379	0923	57
58	8903	0911	1097	8963	1067	1037	9022	1224	0978	9078	1382	0922	58
59	8904	0914	1096	8964	1069	1036	9023	1226	0977	9079	1385	0921	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	54 Degrees.			55 Degrees.			56 Degrees.			57 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.9080	0.1387	0.0920	9.9134	0.1548	0.0866	9.9186	0.1710	0.0814	9.9236	0.1875	0.0764	0
1	9080	1390	0920	9135	1550	0865	9187	1713	0813	9237	1878	0763	1
2	9081	1393	0919	9135	1553	0865	9187	1716	0813	9238	1880	0762	2
3	9082	1395	0918	9136	1556	0864	9188	1718	0812	9238	1883	0762	3
4	9083	1398	0917	9137	1558	0863	9189	1721	0811	9239	1886	0761	4
5	9084	1401	0916	9138	1561	0862	9190	1724	0810	9240	1889	0760	5
6	9085	1403	0915	9139	1564	0861	9191	1726	0809	9241	1891	0759	6
7	9086	1406	0914	9140	1567	0860	9192	1729	0808	9242	1894	0758	7
8	9087	1409	0913	9141	1569	0859	9193	1732	0807	9242	1897	0758	8
9	9088	1411	0912	9142	1572	0858	9193	1735	0807	9243	1900	0757	9
10	9.9089	0.1414	0.0911	9.9142	0.1575	0.0858	9.9194	0.1737	0.0806	9.9244	0.1903	0.0756	10
11	9090	1417	0910	9143	1577	0857	9195	1740	0805	9245	1905	0755	11
12	9091	1419	0909	9144	1580	0856	9196	1743	0804	9246	1908	0754	12
13	9091	1422	0909	9145	1583	0855	9197	1746	0803	9247	1911	0753	13
14	9092	1425	0908	9146	1585	0854	9198	1748	0802	9247	1914	0753	14
15	9093	1427	0907	9147	1588	0853	9198	1751	0802	9248	1916	0752	15
16	9094	1430	0906	9148	1591	0852	9199	1754	0801	9249	1919	0751	16
17	9095	1433	0905	9149	1594	0851	9200	1757	0800	9250	1922	0750	17
18	9096	1435	0904	9149	1596	0851	9201	1759	0799	9251	1925	0749	18
19	9097	1438	0903	9150	1599	0850	9202	1762	0798	9251	1928	0749	19
20	9.9098	0.1441	0.0902	9.9151	0.1602	0.0849	9.9203	0.1765	0.0797	9.9252	0.1930	0.0748	20
21	9099	1443	0901	9152	1604	0848	9204	1768	0796	9253	1933	0747	21
22	9100	1446	0900	9153	1607	0847	9204	1770	0796	9254	1936	0746	22
23	9101	1449	0899	9154	1610	0846	9205	1773	0795	9255	1939	0745	23
24	9101	1451	0899	9155	1612	0845	9206	1776	0794	9255	1941	0745	24
25	9102	1454	0898	9156	1615	0844	9207	1778	0793	9256	1944	0744	25
26	9103	1457	0897	9156	1618	0844	9208	1781	0792	9257	1947	0743	26
27	9104	1459	0896	9157	1621	0843	9209	1784	0791	9258	1950	0742	27
28	9105	1462	0895	9158	1623	.0842	9209	1787	0791	9259	1953	0741	28
29	9106	1465	0894	9159	1626	.0841	9210	1789	0790	9259	1955	0741	29
30	9.9107	0.1467	0.0893	9.9160	0.1629	0.0840	9.9211	0.1792	0.0789	9.9260	0.1958	0.0740	30
31	9108	1470	0892	9161	1631	0839	9212	1795	0788	9261	1961	0739	31
32	9109	1473	0891	9162	1634	0838	9213	1798	0787	9262	1964	0738	32
33	9110	1475	0890	9163	1637	0837	9214	1800	0786	9263	1966	0737	33
34	9110	1478	0890	9163	1639	0837	9914	1803	0786	9264	1969	0736	34
35	9111	1481	0889	9164	1642	0836	9215	1806	0785	9264	1972	0736	35
36	9112	1483	0888	9165	1645	0835	9216	1809	0784	9265	1975	0735	36
37	9113	1486	0887	9166	1648	0834	9217	1811	0783	9266	1978	0734	37
38	9114	1489	0886	9167	1650	0833	9218	1814	0782	9267	1980	0733	38
39	9115	1491	0885	9168	1653	0832	9219	1817	0781	9268	1983	0732	39
40	9.9116	0.1494	0.0884	9.9169	0.1656	0.0831	9.9219	0.1820	0.0781	9.9268	0.1986	0.0732	40
41	9117	1497	0883	9169	1658	0831	9220	1822	0780	9269	1989	0731	41
42	9118	1499	0882	9170	1661	0830	9221	1825	0779	9270	1992	0730	42
43	9119	1502	0881	9171	1664	0829	9222	1828	0778	9271	1994	0729	43
44	9119	1505	0881	9172	1667	0828	9223	1831	0777	8272	1997	0728	44
45	9120	1507	0880	9173	1669	0827	9224	1833	0776	9272	2000	0728	45
46	9121	1510	0879	9174	1672	0826	9224	1836	0776	9273	2003	0727	46
47	9122	1513	0878	9175	1675	0825	9225	1839	0775	9274	2006	0726	47
48	9123	1516	0877	9175	1677	0825	9226	1842	0774	9275	2008	0725	48
49	9124	1518	0876	9176	1680	0824	9227	1844	0773	9275	2011	0725	49
50	9.9125	0.1521	0.0875	9.9177	0.1683	0.0824	9.9228	0.1847	0.0772	9.9276	0.2014	0.0724	50
51	9126	1524	0874	9178	1686	0823	9229	1850	0771	9277	2017	0723	51
52	9127	1526	0873	9179	1688	0822	9229	1853	0771	9278	2020	0722	52
53	9127	1529	0873	9180	1691	0821	9230	1855	0770	9279	2022	0721	53
54	9128	1532	0872	9181	1694	0820	9231	1858	0769	9279	2025	0721	54
55	9129	1534	0871	9181	1697	0819	9232	1861	0768	9280	2028	0720	55
56	9130	1537	0870	9182	1699	0819	9233	1864	0767	9281	2031	0719	56
57	9131	1540	0869	9183	1702	0818	9233	1867	0767	9282	2034	0718	57
58	9132	1542	0868	9184	1705	0817	9234	1869	0766	9283	2036	0717	58
59	9133	1545	0867	9185	1707	0816	9235	1872	0765	9283	2039	0717	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	58 Degrees.			59 Degrees.			60 Degrees.			61 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.9284	0.2042	0.0716	9.9331	0.2212	0.0669	9.9375	0.2386	0.0625	9.9418	0.2562	0.0582	0
1	9285	2045	0715	9331	2215	0669	9376	2389	0624	9419	2565	0581	1
2	9286	2048	0714	9332	2218	0668	9377	2391	0623	9420	2568	0580	2
3	9287	2051	0713	9333	2221	0667	9377	2394	0623	9420	2571	0580	3
4	9287	2053	0713	9334	2224	0666	9378	2397	0622	9421	2574	0579	4
5	9288	2056	0712	9334	2227	0666	9379	2400	0621	9422	2577	0578	5
6	9289	2059	0711	9335	2229	0665	9380	2403	0620	9422	2580	0578	6
7	9290	2062	0710	9336	2232	0664	9380	2406	0620	9423	2583	0577	7
8	9291	2065	0709	9337	2235	0663	9381	2409	0619	9424	2586	0576	8
9	9291	2067	0709	9337	2238	0663	9382	2412	0618	9424	2589	0576	9
10	9.9292	0.2070	0.0708	9.9338	0.2241	0.0662	9.9383	0.2415	0.0617	9.9425	0.2592	0.0575	10
11	9293	2073	0707	9339	2244	0661	9383	2418	0617	9426	2595	0574	11
12	9294	2076	0706	9340	2247	0660	9384	2421	0616	9426	2598	0574	12
13	9294	2079	0706	9340	2250	0660	9385	2424	0615	9427	2601	0573	13
14	9295	2082	0705	9341	2252	0659	9385	2427	0615	9428	2604	0572	14
15	9296	2084	0704	9342	2255	0658	9386	2429	0614	9429	2607	0571	15
16	9297	2087	0703	9343	2258	0657	9387	2432	0613	9429	2610	0571	16
17	9298	2090	0702	9343	2261	0657	9388	2435	0612	9430	2613	0570	17
18	9298	2093	0702	9344	2264	0656	9388	2438	0612	9431	2616	0569	18
19	9299	2096	0701	9345	2267	0655	9389	2441	0611	9431	2619	0569	19
20	9.9300	0.2099	0.0700	9.9346	0.2270	0.0654	9.9390	0.2444	0.0610	9.9432	0.2622	0.0568	20
21	9301	2101	0699	9346	2273	0654	9391	2447	0609	9433	2625	0567	21
22	9301	2104	0699	9347	2275	0653	9391	2450	0609	9433	2628	0567	22
23	9302	2107	0698	9348	2278	0652	9392	2453	0608	9434	2631	0566	23
24	9303	2110	0697	9349	2281	0651	9393	2456	0607	9435	2634	0565	24
25	9304	2113	0696	9349	2284	0651	9393	2459	0607	9435	2637	0565	25
26	9305	2115	0695	9350	2287	0650	9394	2462	0606	9436	2640	0564	26
27	9305	2118	0695	9351	2290	0649	9395	2465	0605	9437	2643	0563	27
28	9306	2121	0694	9352	2293	0648	9396	2468	0604	9438	2646	0562	28
29	9307	2124	0693	9352	2296	0648	9396	2471	0604	9438	2649	0562	29
30	9.9308	0.2127	0.0692	9.9353	0.2299	0.0647	9.9397	0.2474	0.0603	9.9439	0.2652	0.0561	30
31	9308	2130	0692	9354	2301	0646	6398	2477	0602	9440	2655	0560	31
32	9309	2132	0691	9355	2304	0645	9398	2479	0602	9440	2658	0560	32
33	9310	2135	0690	9355	2307	0645	9399	2482	0601	9441	2661	0559	33
34	9311	2138	0689	9356	2310	0644	9400	2485	0600	9442	2664	0558	34
35	9312	2141	0688	9357	2313	0643	9401	2488	0599	9442	2667	0558	35
36	9312	2144	0688	9358	2316	0642	9401	2491	0599	9443	2670	0557	36
37	9313	2147	0687	9358	2319	0642	9402	2494	0598	9444	2673	0556	37
38	9314	2150	0686	9359	2322	0641	9403	2497	0597	9444	2677	0556	38
39	9315	2152	0685	9360	2325	0640	9403	2500	0597	9445	2680	0555	39
40	9.9315	0.2155	0.0685	9.9361	0.2327	0.0639	9.9404	0.2503	0.0596	9.9446	0.2683	0.0554	40
41	9316	2158	0684	9361	2330	0639	9405	2506	0595	9447	2686	0553	41
42	9317	2161	0683	9362	2333	0638	9406	2509	0594	9447	2689	0553	42
43	9318	2164	0682	9363	2336	0637	9406	2512	0594	9448	2692	0552	43
44	9318	2167	0682	9364	2339	0636	9407	2515	0593	9449	2695	0551	44
45	9319	2169	0681	9364	2342	0636	9408	2518	0592	9449	2698	0551	45
46	9320	2172	0680	9365	2345	0635	9408	2521	0592	9450	2701	0550	46
47	9321	2175	0679	9366	2348	0634	9409	2524	0591	9451	2704	0549	47
48	9322	2178	0678	9367	2351	0633	9410	2527	0590	9451	2707	0549	48
49	9322	2181	0678	9367	2354	0633	9410	2530	0590	9452	2710	0548	49
50	9.9323	0.2184	0.0677	9.9368	0.2356	0.0632	9.9411	0.2533	0.0589	9.9453	0.2713	0.0547	50
51	9324	2187	0676	9369	2359	0631	9412	2536	0588	9453	2716	0547	51
52	9325	2189	0675	9369	2362	0631	9413	2539	0587	9454	2719	0546	52
53	9325	2192	0675	9370	2365	0630	9413	2542	0587	9455	2722	0545	53
54	9326	2195	0674	9371	2368	0629	9414	2545	0586	9455	2725	0545	54
55	9327	2198	0673	9372	2371	0628	9415	2548	0585	9456	2728	0544	55
56	9328	2201	0672	9372	2374	0628	9415	2551	0585	9457	2731	0543	56
57	9328	2204	0672	9373	2377	0627	9416	2554	0584	9457	2734	0543	57
58	9329	2207	0671	9374	2380	0626	9417	2557	0583	9458	2737	0542	58
59	9330	2209	0670	9375	2383	0625	9417	2560	0583	9459	2740	0541	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	62 Degrees.			63 Degrees.			64 Degrees.			65 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.9459	0.2743	0.0541	9.9499	0.2928	0.0501	9.9537	0.3118	0.0463	9.9573	0.3313	0.0427	0
1	9460	2746	0540	9499	2931	0501	9537	3121	0463	9573	3317	0427	1
2	9461	2749	0539	9500	2935	0500	9538	3125	0462	9574	3320	0426	2
3	9461	2752	0539	9501	2938	0499	9538	3128	0462	9575	3323	0425	3
4	9462	2755	0538	9501	2941	0499	9539	3131	0461	9575	3326	0425	4
5	9463	2759	0537	9502	2944	0498	9540	3134	0460	9576	3330	0424	5
6	9463	2762	0537	9503	2947	0497	9540	3137	0460	9576	3333	0424	6
7	9464	2765	0536	9503	2950	0497	9541	3141	0459	9577	3336	0423	7
8	9465	2768	0535	9504	2953	0496	9542	3144	0458	9577	3340	0423	8
9	9465	2771	0535	9505	2957	0495	9542	3147	0458	9578	3343	0422	9
10	9.9466	0.2774	0.0534	9.9505	0.2960	0.0495	9.9543	0.3150	0.0457	9.9579	0.3346	0.0421	10
11	9467	2777	0533	9506	2963	0494	9543	3154	0457	9579	3350	0421	11
12	9467	2780	0533	9507	2966	0493	9544	3157	0456	9580	3353	0420	12
13	9468	2783	0532	9507	2969	0493	9545	3160	0455	9580	3356	0420	13
14	9469	2786	0531	9508	2972	0492	9545	3163	0455	9581	3360	0419	14
15	9469	2789	0531	9508	2975	0492	9546	3166	0454	9582	3363	0418	15
16	9470	2792	0530	9509	2978	0491	9546	3170	0454	9582	3366	0418	16
17	9471	2795	0529	9510	2982	0490	9547	3173	0453	9583	3370	0417	17
18	9471	2798	0529	9510	2985	0490	9548	3176	0452	9583	3373	0417	18
19	9472	2801	0528	9511	2988	0489	9548	3179	0452	9584	3376	0416	19
20	9.9473	0.2804	0.0527	9.9512	0.2991	0.0488	9.9549	0.3183	0.0451	9.9584	0.3380	0.0416	20
21	9473	2808	0527	9512	2994	0488	9549	3186	0451	9585	3383	0415	21
22	9474	2811	0526	9513	2997	0487	9550	3189	0450	9586	3386	0414	22
23	9475	2814	0525	9513	3001	0487	9551	3192	0449	9586	3390	0414	23
24	9475	2817	0525	9514	3004	0486	9551	3196	0449	9587	3393	0413	24
25	9476	2820	0524	9515	3007	0485	9552	3199	0448	9587	3396	0413	25
26	9477	2823	0523	9515	3010	0485	9552	3202	0448	9588	3300	0412	26
27	9477	2826	0523	9516	3013	0484	9553	3205	0447	9589	3403	0411	27
28	9478	2829	0522	9517	3016	0483	9554	3209	0446	9589	3406	0411	28
29	9479	2832	0521	9517	3019	0483	9554	3212	0446	9590	3410	0410	29
30	9.9479	0.2835	0.0521	9.9518	0.3023	0.0482	9.9555	0.3215	0.0445	9.9590	0.3413	0.0410	30
31	9480	2838	0520	9519	3026	0481	9555	3218	0445	9591	3416	0409	31
32	9481	2841	0519	9519	3029	0481	9556	3222	0444	9591	3420	0409	32
33	9481	2844	0519	9520	3032	0480	9557	3225	0443	9592	3423	0408	33
34	9482	2848	0518	9520	3035	0480	9557	3228	0443	9593	3426	0407	34
35	9483	2851	0517	9521	3038	0479	9558	3231	0442	9593	3430	0407	35
36	9483	2854	0517	9522	3042	0478	9558	3235	0442	9594	3433	0406	36
37	9484	2857	0516	9522	3045	0478	9559	3238	0441	9594	3436	0406	37
38	9485	2860	0515	9523	3048	0477	9560	3241	0440	9595	3440	0405	38
39	9485	2863	0515	9524	3051	0476	9560	3244	0440	9595	3443	0405	39
40	9.9486	0.2866	0.0514	9.9524	0.3054	0.0476	9.9561	0.3248	0.0439	9.9596	0.3447	0.0404	40
41	9487	2869	0513	9525	3058	0475	9561	3251	0439	9597	3450	0403	41
42	9487	2872	0513	9525	3061	0475	9562	3254	0438	9597	3453	0403	42
43	9488	2875	0512	9526	3064	0474	9563	3257	0437	9598	3457	0402	43
44	9488	2879	0512	9527	3067	0473	9563	3260	0437	9598	3460	0402	44
45	9489	2882	0511	9527	3070	0473	9564	3264	0436	9599	3463	0401	45
46	9490	2885	0510	9528	3073	0472	9564	3267	0436	9599	3467	0401	46
47	9490	2888	0510	9529	3077	0471	9565	3271	0435	9600	3470	0400	47
48	9491	2891	0509	9529	3080	0471	9566	3274	0434	9601	3474	0399	48
49	9492	2894	0508	9530	3083	0470	9566	3277	0434	9601	3477	0399	49
50	9.9492	0.2897	0.0508	9.9530	0.3086	0.0470	9.9567	0.3280	0.0433	9.9602	0.3480	0.0398	50
51	9493	2900	0507	9531	3089	0469	9567	3284	0433	9602	3484	0398	51
52	9494	2903	0506	9532	3093	0468	9568	3287	0432	9603	3487	0397	52
53	9494	2907	0506	9532	3096	0468	9569	3290	0431	9603	3490	0397	53
54	9495	2910	0505	9533	3099	0467	9569	3294	0431	9604	3494	0396	54
55	9496	2913	0504	9534	3102	0466	9570	3297	0430	9604	3497	0396	55
56	9496	2916	0504	9534	3105	0466	9570	3300	0430	9605	3501	0395	56
57	9497	2919	0503	9535	3109	0465	9571	3303	0429	9606	3504	0394	57
58	9498	2922	0502	9535	3112	0465	9572	3307	0428	9606	3507	0394	58
59	9498	2925	0502	9536	3115	0464	9572	3310	0428	9607	3511	0393	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	66 Degrees. Sine	Tangent	Cosecant	67 Degrees. Sine	Tangent	Cosecant	68 Degrees. Sine	Tangent	Cosecant	69 Degrees. Sine	Tangent	Cosecant	M.
0	9.9607	0.3514	0.0393	9.9640	0.3722	0.0360	9.9672	0.3936	0.0328	9.9702	0.4158	0.0298	0
1	9608	3518	0393	9641	3725	0359	9672	3940	0328	9702	4162	0298	1
2	9608	3521	0392	9641	3729	0359	9673	3943	0327	9703	4166	0297	2
3	9609	3524	0391	9642	3732	0358	9673	3947	0327	9703	4170	0297	3
4	9610	3528	0390	9642	3736	0358	9674	3950	0326	9703	4173	0297	4
5	9610	3531	0390	9643	3739	0357	9674	3954	0326	9704	4177	0296	5
6	9611	3535	0389	9643	3743	0357	9675	3958	0325	9704	4181	0296	6
7	9611	3538	0389	9644	3746	0356	9675	3961	0325	9705	4185	0295	7
8	9612	3541	0388	9645	3750	0355	9676	3965	0324	9705	4189	0295	8
9	9612	3545	0388	9645	3753	0355	9676	3969	0324	9706	4192	0294	9
10	9.9613	0.3548	0.0387	9.9646	0.3757	0.0354	9.9677	0.3972	0.0323	9.9706	0.4196	0.0294	10
11	9613	3552	0387	9646	3760	0354	9677	3976	0323	9707	4200	0293	11
12	9614	3555	0386	9647	3764	0353	9678	3980	0322	9707	4204	0293	12
13	9615	3559	0385	9647	3767	0353	9678	3983	0322	9708	4208	0292	13
14	9615	3562	0385	9648	3771	0352	9679	3987	0321	9708	4211	0292	14
15	9616	3565	0384	9648	3774	0352	9679	3991	0321	9709	4215	0291	15
16	9616	3569	0384	9649	3778	0351	9680	3994	0320	9709	4219	0291	16
17	9617	3572	0383	9649	3781	0351	9680	3998	0320	9710	4223	0290	17
18	9617	3576	0383	9650	3785	0350	9681	4002	0319	9710	4227	0290	18
19	9618	3579	0382	9650	3789	0350	9681	4005	0319	9711	4230	0289	19
20	9.9618	0.3583	0.0382	9.9651	0.3792	0.0349	9.9682	0.4009	0.0318	9.9711	0.4234	0.0289	20
21	9619	3586	0381	9651	3796	0349	9682	4013	0318	9712	4238	0288	21
22	9620	3589	0380	9652	3799	0348	9683	4016	0317	9712	4242	0288	22
23	9620	3593	0380	9652	3803	0348	9683	4020	0317	9713	4246	0287	23
24	9621	3596	0379	9653	3806	0347	9684	4024	0316	9713	4250	0287	24
25	9621	3600	0379	9654	3810	0346	9684	4028	0316	9714	4253	0286	25
26	9622	3603	0378	9654	3813	0346	9685	4031	0315	9714	4257	0286	26
27	9622	3607	0378	9655	3817	0345	9685	4035	0315	9714	4261	0286	27
28	9623	3610	0377	9655	3821	0345	9686	4039	0314	9715	4265	0285	28
29	9623	3614	0377	9656	3824	0344	9686	4042	0314	9715	4269	0285	29
30	9.9624	0.3617	0.0376	9.9656	0.3828	0.0344	9.9687	0.4046	0.0313	9.9716	0.4273	0.0284	30
31	9625	3620	0375	9657	3831	0343	9687	4050	0313	9716	4276	0284	31
32	9625	3624	0375	9657	3835	0343	9688	4053	0312	9717	4280	0283	32
33	9626	3627	0374	9658	3838	0342	9688	4057	0312	9717	4284	0283	33
34	9626	3631	0374	9658	3842	0342	9689	4061	0311	9718	4288	0282	34
35	9627	3634	0373	9659	3846	0341	9689	4065	0311	9718	4292	0282	35
36	9627	3638	0373	9659	3849	0341	9690	4068	0310	9719	4296	0281	36
37	9628	3641	0372	9659	3853	0341	9690	4072	0310	9719	4300	0281	37
38	9628	3645	0372	9660	3856	0340	9691	4076	0309	9720	4304	0280	38
39	9629	3648	0371	9660	3860	0340	9691	4079	0309	9720	4307	0280	39
40	9.9629	0.3652	0.0371	9.9661	0.3864	0.0339	9.9692	0.4083	0.0308	9.9721	0.4311	0.0279	40
41	9630	3655	0370	9661	3867	0339	9692	4087	0308	9721	4315	0279	41
42	9631	3659	0369	9662	3871	0338	9693	4091	0307	9722	4319	0278	42
43	9631	3662	0369	9663	3874	0337	9693	4094	0307	9722	4323	0278	43
44	9632	3666	0368	9663	3878	0337	9694	4098	0306	9722	4327	0278	44
45	9632	3669	0368	9664	3882	0336	9694	4102	0306	9723	4331	0277	45
46	9633	3673	0367	9664	3885	0336	9695	4106	0305	9723	4335	0277	46
47	9633	3676	0367	9665	3889	0335	9695	4109	0305	9724	4338	0276	47
48	9634	3679	0366	9666	3892	0334	9696	4113	0304	9724	4342	0276	48
49	9634	3683	0366	9666	3896	0334	9696	4117	0304	9725	4346	0275	49
50	9.9635	0.3686	0.0365	9.9667	0.3900	0.0333	9.9697	0.4121	0.0303	9.9725	0.4350	0.0275	50
51	9635	3690	0365	9667	3903	0333	9697	4124	0303	9726	4354	0274	51
52	9636	3693	0364	9668	3907	0332	9698	4128	0302	9726	4358	0274	52
53	9637	3697	0363	9668	3911	0332	9698	4132	0302	9727	4362	0273	53
54	9637	3700	0363	9669	3914	0331	9699	4136	0301	9727	4366	0273	54
55	9638	3704	0362	9669	3918	0331	9699	4139	0301	9728	4370	0272	55
56	9638	3707	0362	9670	3921	0330	9700	4143	0300	9728	4374	0272	56
57	9639	3711	0361	9670	3925	0330	9700	4147	0300	9728	4378	0272	57
58	9639	3714	0361	9671	3929	0329	9701	4151	0299	9729	4381	0271	58
59	9640	3718	0360	9671	3932	0329	9701	4154	0299	9729	4385	0271	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	70 Degrees.			71 Degrees.			72 Degrees.			73 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.9730	0.4389	0.0270	9.9757	0.4630	0.0243	9.9782	0.4882	0.0218	9.9806	0.5147	0.0194	0
1	9730	4393	0270	9757	4634	0243	9782	4887	0218	9806	5151	0194	1
2	9731	4397	0269	9758	4639	0242	9783	4891	0217	9807	5156	0193	2
3	9731	4401	0269	9758	4643	0242	9783	4895	0217	9807	5160	0193	3
4	9732	4405	0268	9758	4647	0242	9784	4899	0216	9808	5165	0192	4
5	9732	4409	0268	9759	4651	0241	9784	4904	0216	9808	5169	0192	5
6	9733	4413	0267	9759	4655	0241	9785	4908	0215	9808	5174	0192	6
7	9733	4417	0267	9760	4659	0240	9785	4912	0215	9809	5178	0191	7
8	9734	4421	0266	9760	4663	0240	9785	4917	0215	9809	5183	0191	8
9	9734	4425	0266	9761	4667	0239	9786	4921	0214	9809	5187	0191	9
10	9.9734	0.4429	0.0266	9.9761	0.4671	0.0239	9.9786	0.4925	0.0214	9.9810	0.5192	0.0190	10
11	9735	4433	0265	9761	4676	0239	9787	4930	0213	9810	5197	0190	11
12	9735	4437	0265	9762	4680	0238	9787	4934	0213	9811	5201	0189	12
13	9736	4441	0264	9762	4684	0238	9787	4938	0213	9811	5206	0189	13
14	9736	4445	0264	9763	4688	0237	9788	4943	0212	9811	5210	0189	14
15	9737	4449	0263	9763	4692	0237	9788	4947	0212	9812	5215	0188	15
16	9737	4453	0263	9764	4696	0236	9789	4951	0211	9812	5219	0188	16
17	9738	4457	0262	9764	4701	0236	9789	4956	0211	9812	5224	0188	17
18	9738	4461	0262	9764	4705	0236	9789	4960	0211	9813	5229	0187	18
19	9739	4465	0261	9765	4709	0235	9790	4965	0210	9813	5233	0187	19
20	9.9739	0.4469	0.0261	9.9765	0.4713	0.0235	9.9790	0.4969	0.0210	9.9814	0.5238	0.0186	20
21	9739	4473	0261	9766	4717	0234	9791	4973	0209	9814	5243	0186	21
22	9740	4476	0260	9766	4721	0234	9791	4978	0209	9814	5247	0186	22
23	9740	4480	0260	9767	4725	0233	9791	4982	0209	9815	5252	0185	23
24	9741	4484	0259	9767	4730	0233	9792	4986	0208	9815	5256	0185	24
25	9741	4488	0259	9768	4734	0233	9792	4991	0208	9815	5261	0185	25
26	9742	4492	0258	9768	4738	0232	9793	4995	0207	9816	5265	0184	26
27	9742	4496	0258	9768	4742	0232	9793	5000	0207	9816	5270	0184	27
28	9743	4500	0257	9769	4746	0231	9793	5004	0207	9817	5275	0183	28
29	9743	4505	0257	9769	4751	0231	9794	5008	0206	9817	5279	0183	29
30	9.9743	0.4509	0.0257	9.9770	0.4755	0.0230	9.9794	0.5013	0.0206	9.9817	0.5284	0.0183	30
31	9744	4513	0256	9770	4759	0230	9795	5017	0205	9818	5289	0182	31
32	9744	4517	0256	9770	4763	0230	9795	5022	0205	9818	5293	0182	32
33	9745	4521	0255	9771	4767	0229	9795	5026	0205	9818	5298	0182	33
34	9745	4525	0255	9771	4772	0229	9796	5030	0204	9819	5303	0181	34
35	9746	4529	0254	9772	4776	0228	9796	5035	0204	9819	5307	0181	35
36	9746	4533	0254	9772	4780	0228	9797	5039	0203	9820	5312	0180	36
37	9747	4537	0253	9773	4784	0227	9797	5044	0203	9820	5317	0180	37
38	9747	4541	0253	9773	4788	0227	9797	5048	0203	9820	5321	0180	38
39	9747	4545	0253	9773	4793	0227	9798	5053	0202	9821	5326	0179	39
40	9.9748	0.4549	0.0252	9.9774	0.4797	0.0226	9.9798	0.5057	0.0202	9.9821	0.5331	0.0179	40
41	9748	4553	0252	9774	4801	0226	9799	5061	0201	9821	5335	0179	41
42	9749	4557	0251	9774	4805	0226	9799	5066	0201	9822	5340	0178	42
43	9749	4561	0251	9775	4810	0225	9799	5070	0201	9822	5345	0178	43
44	9750	4565	0250	9775	4814	0225	9800	5075	0200	9823	5349	0177	44
45	9750	4569	0250	9776	4818	0224	9800	5079	0200	9823	5354	0177	45
46	9751	4573	0249	9776	4822	0224	9801	5084	0199	9823	5359	0177	46
47	9751	4577	0249	9777	4827	0223	9801	5088	0199	9824	5363	0176	47
48	9751	4581	0249	9777	4831	0223	9801	5093	0199	9824	5368	0176	48
49	9752	4585	0248	9778	4835	0222	9802	5097	0198	9824	5373	0176	49
50	9.9752	0.4589	0.0248	9.9778	0.4839	0.0222	9.9802	0.5102	0.0198	9.9825	0.5378	0.0175	50
51	9753	4593	0247	9778	4844	0222	9802	5106	0198	9825	5382	0175	51
52	9753	4598	0247	9779	4848	0221	9803	5111	0197	9826	5387	0174	52
53	9754	4602	0246	9779	4852	0221	9803	5115	0197	9826	5392	0174	53
54	9754	4606	0246	9780	4857	0220	9804	5120	0196	9826	5397	0174	54
55	9755	4610	0245	9780	4861	0220	9804	5124	0196	9827	5301	0173	55
56	9755	4614	0245	9780	4865	0220	9804	5129	0196	9827	5306	0173	56
57	9755	4618	0245	9781	4869	0219	9805	5133	0195	9827	5311	0173	57
58	9756	4622	0244	9781	4874	0219	9805	5138	0195	9828	5316	0172	58
59	9756	4626	0244	9782	4878	0218	9806	5142	0194	9828	5420	0172	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	74 Degrees.			75 Degrees.			76 Degrees.			77 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.9828	0.5425	0.0172	9.9849	0.5719	0.0151	9.9869	0.6032	0.0131	9.9887	0.6366	0.0113	0
1	9829	5430	0171	9850	5725	0150	9869	6038	0131	9888	6372	0112	1
2	9829	5435	0171	9850	5730	0150	9870	6043	0130	9888	6378	0112	2
3	9830	5439	0170	9850	5735	0150	9870	6048	0130	9888	6384	0112	3
4	9830	5444	0170	9851	5740	0149	9870	6054	0130	9888	6389	0112	4
5	9830	5449	0170	9851	5745	0149	9871	6059	0129	9889	6395	0111	5
6	9831	5454	0169	9851	5750	0149	9871	6065	0129	9889	6401	0111	6
7	9831	5459	0169	9852	5755	0148	9871	6070	0129	9889	6407	0111	7
8	9831	5463	0169	9852	5760	0148	9872	6076	0128	9890	6413	0110	8
9	9832	5468	0168	9852	5765	0148	9872	6081	0128	9890	6419	0110	9
10	9.9832	0.5473	0.0168	9.9853	0.5770	0.0147	9.9872	0.6086	0.0128	9.9890	0.6424	0.0110	10
11	9832	5478	0168	9853	5775	0147	9872	6092	0128	9890	6430	0110	11
12	9833	5483	0167	9853	5780	0147	9873	6097	0127	9891	6436	0109	12
13	9833	5487	0167	9854	5786	0146	9873	6103	0127	9891	6442	0109	13
14	9833	5492	0167	9854	5791	0146	9873	6108	0127	9891	6448	0109	14
15	9834	5497	0166	9854	5796	0146	9874	6114	0126	9892	6454	0108	15
16	9834	5502	0166	9855	5801	0145	9874	6119	0126	9892	6459	0108	16
17	9835	5507	0165	9855	5806	0145	9874	6125	0126	9892	6465	0108	17
18	9835	5512	0165	9855	5811	0145	9875	6130	0125	9892	6471	0108	18
19	9835	5516	0165	9856	5816	0144	9875	6136	0125	9893	6477	0107	19
20	9.9836	0.5521	0.0164	9.9856	0.5822	0.0144	9.9875	0.6141	0.0125	9.9893	0.6483	0.0107	20
21	9836	5526	0164	9856	5827	0144	9876	6147	0124	9893	6489	0107	21
22	9836	5531	0164	9857	5832	0143	9876	6152	0124	9894	6495	0106	22
23	9837	5536	0163	9857	5837	0143	9876	6158	0124	9894	6501	0106	23
24	9837	5541	0163	9857	5842	0143	9876	6163	0124	9894	6507	0106	24
25	9837	5546	0163	9858	5847	0142	9877	6169	0123	9894	6513	0106	25
26	9838	5551	0162	9858	5853	0142	9877	6174	0123	9895	6519	0105	26
27	9838	5555	0162	9858	5858	0142	9877	6180	0123	9895	6525	0105	27
28	9838	5560	0162	9859	5863	0141	9878	6185	0122	9895	6531	0105	28
29	9839	5565	0161	9859	5868	0141	9878	6191	0122	9896	6536	0104	29
30	9.9839	0.5570	0.0161	9.9859	0.5873	0.0141	9.9878	0.6196	0.0122	9.9896	0.6542	0.0104	30
31	9839	5575	0161	9860	5879	0140	9879	6202	0121	9896	6548	0104	31
32	9839	5580	0161	9860	5884	0140	9879	6208	0121	9896	6554	0104	32
33	9840	5585	0160	9860	5889	0140	9879	6213	0121	9897	6560	0103	33
34	9841	5590	0159	9861	5894	0139	9880	6219	0120	9897	6566	0103	34
35	9841	5595	0159	9861	5900	0139	9880	6224	0120	9897	6572	0103	35
36	9841	5600	0159	9861	5905	0139	9880	6230	0120	9897	6578	0103	36
37	9842	5605	0158	9862	5910	0138	9880	6236	0120	9898	6584	0102	37
38	9842	5610	0158	9862	5915	0138	9881	6241	0119	9898	6591	0102	38
39	9842	5615	0158	9862	5921	0138	9881	6247	0119	9898	6597	0102	39
40	9.9843	0.5619	0.0157	9.9863	0.5926	0.0137	9.9881	0.6252	0.0119	9.9899	0.6603	0.0101	40
41	9843	5624	0157	9863	5931	0137	9882	6258	0118	9899	6609	0101	41
42	9843	5629	0157	9863	5936	0137	9882	6264	0118	9899	6615	0101	42
43	9844	5634	0156	9864	5942	0136	9882	6269	0118	9899	6621	0101	43
44	8844	5639	0156	9864	5947	0136	9883	6275	0117	9900	6627	0100	44
45	9844	5644	0156	9864	5952	0136	9883	6281	0117	9900	6633	0100	45
46	9845	5649	0155	9865	5958	0135	9883	6286	0117	9900	6639	0100	46
47	9845	5654	0155	9865	5963	0135	9883	6292	0117	9901	6645	0099	47
48	9845	5659	0155	9865	5968	0135	9884	6298	0116	9901	6651	0099	48
49	9846	5664	0154	9866	5973	0134	9884	6303	0116	9901	6657	0099	49
50	9.9846	0.5669	0.0154	9.9866	0.5979	0.0134	9.9884	0.6310	0.0116	9.9901	0.6664	0.0099	50
51	9846	5674	0154	9866	5984	0134	9885	6315	0115	9902	6670	0098	51
52	9847	5679	0153	9867	5989	0133	9885	6320	0115	9902	6676	0098	52
53	9847	5684	0153	9867	5995	0133	9885	6326	0115	9902	6682	0098	53
54	9847	5689	0153	9867	6000	0133	9885	6332	0115	9902	6688	0098	54
55	9848	5694	0152	9867	6005	0133	9886	6338	0114	9903	6694	0097	55
56	9848	5699	0152	9868	6011	0132	9886	6343	0114	9903	6701	0097	56
57	9848	5704	0152	9868	6016	0132	9886	6349	0114	9903	6707	0097	57
58	9849	5709	0151	9868	6022	0132	9886	6355	0114	9904	6713	0096	58
59	9849	5714	0151	9869	6027	0131	9887	6361	0113	9904	6719	0096	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	78 Degrees.			79 Degrees.			80 Degrees.			81 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.9904	0.6725	0.0096	9.9919	0.7113	0.0081	9.9934	0.7537	0.0066	9.9946	0.8003	0.0054	0
1	9904	6731	0096	9920	7120	0080	9934	7544	0066	9946	8011	0054	1
2	9905	6738	0095	9920	7127	0080	9934	7552	0066	9947	8019	0053	2
3	9905	6744	0095	9920	7134	0080	9934	7559	0066	9947	8027	0053	3
4	9905	6750	0095	9920	7141	0080	9934	7566	0066	9947	8036	0053	4
5	9905	6756	0095	9921	7147	0079	9935	7574	0065	9947	8044	0053	5
6	9906	6763	0094	9921	7154	0079	9935	7581	0065	9947	8052	0053	6
7	9906	6769	0094	9921	7161	0079	9935	7589	0065	9948	8061	0052	7
8	9906	6775	0094	9921	7168	0079	9935	7596	0065	9948	8069	0052	8
9	9906	6781	0094	9922	7175	0078	9936	7604	0064	9948	8077	0052	9
10	9.9907	0.6788	0.0093	9.9922	0.7181	0.0078	9.9936	0.7611	0.0064	9.9948	0.8085	0.0052	10
11	9907	6794	0093	9922	7188	0078	9936	7619	0064	9948	8094	0052	11
12	9907	6800	0093	9922	7195	0078	9936	7626	0064	9949	8102	0051	12
13	9908	6807	0092	9923	7202	0077	9936	7634	0064	9949	8110	0051	13
14	9908	6813	0092	9923	7209	0077	9937	7641	0063	9949	8119	0051	14
15	9908	6819	0092	9923	7216	0077	9937	7649	0063	9949	8127	0051	15
16	9908	6826	0092	9923	7223	0077	9937	7657	0063	9949	8136	0051	16
17	9909	6832	0091	9924	7230	0076	9937	7664	0063	9950	8144	0050	17
18	9909	6838	0091	9924	7236	0076	9937	7672	0063	9950	8152	0050	18
19	9909	6845	0091	9924	7243	0076	9938	7679	0062	9950	8161	0050	19
20	9.9909	0.6851	0.0091	9.9924	0.7250	0.0076	9.9938	0.7687	0.0062	9.9950	0.8169	0.0050	20
21	9910	6858	0090	9925	7257	0075	9938	7695	0062	9950	8178	0050	21
22	9910	6864	0090	9925	7264	0075	9938	7702	0062	9951	8186	0049	22
23	9910	6870	0090	9925	7271	0075	9939	7710	0061	9951	8195	0049	23
24	9910	6877	0090	9925	7278	0075	9939	7718	0061	9951	8203	0049	24
25	9911	6883	0089	9925	7285	0075	9939	7725	0061	9951	8212	0049	25
26	9911	6890	0089	9926	7292	0074	9939	7733	0061	9951	8221	0049	26
27	9911	6896	0089	9926	7299	0074	9939	7741	0061	9951	8229	0049	27
28	9911	6902	0089	9926	7306	0074	9940	7748	0060	9952	8238	0048	28
29	9912	6909	0088	9926	7313	0074	9940	7756	0060	9952	8246	0048	29
30	9.9912	0.6915	0.0088	9.9927	0.7320	0.0073	9.9940	0.7764	0.0060	9.9952	0.8255	0.0048	30
31	9912	6922	0088	9927	7327	0073	9940	7772	0060	9952	8264	0048	31
32	9912	6928	0088	9927	7334	0073	9940	7779	0060	9952	8272	0048	32
33	9913	6935	0087	9927	7342	0073	9941	7787	0059	9953	8281	0047	33
34	9913	6941	0087	9928	7349	0072	9941	7795	0059	9953	8290	0047	34
35	9913	6948	0087	9928	7356	0072	9941	7803	0059	9953	8298	0047	35
36	9913	6954	0087	9928	7363	0072	9941	7811	0059	9953	8307	0047	36
37	9914	6961	0086	9928	7370	0072	9942	7819	0058	9953	8316	0047	37
38	9914	6967	0086	9929	7377	0071	9942	7826	0058	9954	8325	0046	38
39	9914	6974	0086	9929	7384	0071	9942	7834	0058	9954	8333	0046	39
40	9.9914	0.6980	0.0086	9.9929	0.7391	0.0071	9.9942	0.7842	0.0058	9.9954	0.8342	0.0046	40
41	9915	6987	0085	9929	7399	0071	9942	7850	0058	9954	8351	0046	41
42	9915	6994	0085	9929	7406	0071	9943	7858	0057	9954	8360	0046	42
43	9915	7000	0085	9930	7413	0070	9943	7866	0057	9954	8369	0046	43
44	9915	7007	0085	9930	7420	0070	9943	7874	0057	9955	8378	0045	44
45	9916	7013	0084	9930	7427	0070	9943	7882	0057	9955	8387	0045	45
46	9916	7020	0084	9930	7435	0070	9943	7890	0057	9955	8395	0045	46
47	9916	7027	0084	9931	7442	0069	9944	7898	0056	9955	8404	0045	47
48	9916	7033	0084	9931	7449	0069	9944	7906	0056	9955	8413	0045	48
49	9917	7040	0083	9931	7456	0069	9944	7914	0056	9956	8422	0044	49
50	9.9917	0.7047	0.0083	9.9931	0.7464	0.0069	9.9944	0.7922	0.0056	9.9956	0.8431	0.0044	50
51	9917	7053	0083	9931	7471	0069	9944	7930	0056	9956	8440	0044	51
52	9917	7060	0083	9932	7478	0068	9945	7938	0055	9956	8449	0044	52
53	9918	7067	0082	9932	7485	0068	9945	7946	0055	9956	8458	0044	53
54	9918	7073	0082	9932	7493	0068	9945	7954	0055	9956	8467	0044	54
55	9918	7080	0082	9932	7500	0068	9945	7962	0055	9957	8476	0043	55
56	9918	7087	0082	9933	7507	0067	9945	7970	0055	9957	8485	0043	56
57	9919	7093	0081	9933	7515	0067	9946	7978	0054	9957	8495	0043	57
58	9919	7100	0081	9933	7522	0067	9946	7987	0054	9957	8504	0043	58
59	9919	7107	0081	9933	7529	0067	9946	7995	0054	9957	8513	0043	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	82 Degrees.			83 Degrees.			84 Degrees.			85 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.9958	0.8522	0.0042	9.9968	0.9109	0.0032	9.9976	0.9784	0.0024	9.9983	1.0580	0.0017	0
1	9958	8531	0042	9968	9119	0032	9976	9796	0024	9984	0595	0016	1
2	9958	8540	0042	9968	9130	0032	9976	9808	0024	9984	0610	0016	2
3	9958	8550	0042	9968	9140	0032	9977	9820	0023	9984	0624	0016	3
4	9958	8559	0042	9968	9151	0032	9977	9833	0023	9984	0639	0016	4
5	9958	8568	0042	9968	9161	0032	9977	9845	0023	9984	0654	0016	5
6	9959	8577	0041	9968	9172	0032	9977	9857	0023	9984	0669	0016	6
7	9959	8587	0041	9969	9182	0031	9977	9870	0023	9984	0684	0016	7
8	9959	8596	0041	9969	9193	0031	9977	9882	0023	9984	0698	0016	8
9	9959	8605	0041	9969	9204	0031	9977	9895	0023	9984	0713	0016	9
10	9.9959	0.8615	0.0041	9.9969	0.9214	0.0031	9.9977	0.9907	0.0023	9.9985	1.0728	0.0015	10
11	9959	8624	0041	9969	9225	0031	9978	9920	0022	9985	0744	0015	11
12	9960	8633	0040	9969	9236	0031	9978	9932	0022	9985	0759	0015	12
13	9960	8643	0040	9969	9246	0031	9978	9945	0022	9985	0774	0015	13
14	9960	8652	0040	9970	9257	0030	9978	9957	0022	9985	0789	0015	14
15	9960	8662	0040	9970	9268	0030	9978	9970	0022	9985	0804	0015	15
16	9960	8671	0040	9970	9279	0030	9978	9983	0022	9985	0820	0015	16
17	9960	8681	0040	9970	9280	0030	9978	9995	0022	9985	0835	0015	17
18	9961	8690	0039	9970	9301	0030	9978	1.0008	0022	9985	0850	0015	18
19	9961	8700	0039	9970	9312	0030	9979	1.0021	0021	9985	0866	0015	19
20	9.9961	0.8709	0.0039	9.9971	0.9322	0.0029	9.9979	1.0034	0.0021	9.9986	1.0882	0.0014	20
21	9961	8719	0039	9971	9333	0029	9979	0047	0021	9986	0897	0014	21
22	9961	8728	0039	9971	9344	0029	9979	0060	0021	9986	0913	0014	22
23	9962	8738	0038	9971	9355	0029	9979	0073	0021	9986	0929	0014	23
24	9962	8748	0038	9971	9367	0029	9979	0086	0021	9986	0944	0014	24
25	9962	8757	0038	9971	9378	0029	9979	0099	0021	9986	0960	0014	25
26	9962	8767	0038	9971	9389	0029	9979	0112	0021	9986	0976	0014	26
27	9962	8777	0038	9972	9400	0028	9980	0125	0020	9986	0992	0014	27
28	9962	8786	0038	9972	9411	0028	9980	0138	0020	9986	1008	0014	28
29	9963	8796	0037	9972	9422	0028	9980	0151	0020	9986	1024	0014	29
30	9.9963	0.8806	0.0037	9.9972	0.9433	0.0028	9.9980	1.0164	0.0020	9.9987	1.1040	0.0013	30
31	9963	8815	0037	9972	9445	0028	9980	0178	0020	9987	1056	0013	31
32	9963	8825	0037	9972	9456	0028	9980	0191	0020	9987	1073	0013	32
33	9963	8835	0037	9972	9467	0028	9980	0204	0020	9987	1089	0013	33
34	9963	8845	0037	9973	9479	0027	9980	0218	0020	9987	1105	0013	34
35	9964	8855	0036	9973	9490	0027	9981	0231	0019	9987	1122	0013	35
36	9964	8865	0036	9973	9501	0027	9981	0244	0019	9987	1138	0013	36
37	9964	8875	0036	9973	9513	0027	9981	0258	0019	9987	1155	0013	37
38	9964	8884	0036	9973	9524	0027	9981	0271	0019	9987	1171	0013	38
39	9964	8894	0036	9973	9536	0027	9981	0285	0019	9987	1188	0013	39
40	9.9964	0.8904	0.0036	9.9973	0.9547	0.0027	9.9981	1.0299	0.0019	9.9988	1.1205	0.0012	40
41	9964	8914	0036	9974	9559	0026	9981	0312	0019	9988	1222	0012	41
42	9965	8924	0035	9974	9570	0026	9981	0326	0019	9988	1238	0012	42
43	9965	8934	0035	9974	9582	0026	9982	0340	0018	9988	1255	0012	43
44	9965	8945	0035	9974	9593	0026	9982	0354	0018	9988	1272	0012	44
45	9965	8955	0035	9974	9605	0026	9982	0367	0018	9988	1289	0012	45
46	9965	8965	0035	9974	9617	0026	9982	0381	0018	9988	1306	0012	46
47	9965	8975	0035	9974	9629	0026	9982	0395	0018	9988	1324	0012	47
48	9966	8985	0034	9975	9640	0025	9982	0409	0018	9988	1341	0012	48
49	9966	8995	0034	9975	9652	0025	9982	0423	0018	9988	1358	0012	49
50	9.9966	0.9005	0.0034	9.9975	0.9664	0.0025	9.9982	1.0437	0.0018	9.9989	1.1376	0.0011	50
51	9966	9016	0034	9975	9676	0025	9982	0451	0018	9989	1393	0011	51
52	9966	9026	0034	9975	9688	0025	9983	0466	0017	9989	1411	0011	52
53	9966	9036	0034	9975	9700	0025	9983	0480	0017	9989	1428	0011	53
54	9967	9047	0033	9975	9711	0025	9983	0494	0017	9989	1446	0011	54
55	9967	9057	0033	9975	9723	0025	9983	0508	0017	9989	1464	0011	55
56	9967	9067	0033	9976	9735	0024	9983	0523	0017	9989	1482	0011	56
57	9967	9077	0033	9976	9747	0024	9983	0537	0017	9989	1499	0011	57
58	9967	9088	0033	9976	9760	0024	9983	0551	0017	9989	1517	0011	58
59	9967	9098	0033	9976	9772	0024	9983	0566	0017	9989	1535	0011	59

TABLE IX.

Logarithmic Sines, Tangents, and Cosecants.

M.	86 Degrees.			87 Degrees.			88 Degrees.			89 Degrees.			M.
	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	Sine	Tangent	Cosecant	
0	9.9989	1.1554	0.0011	9.9994	1.2806	0.0006	9.9997	1.4569	0.0003	9.9999	1.7581	0.0001	0
1	9990	1572	0010	9994	2830	0006	9997	4606	0003	9999	7654	0001	1
2	9990	1590	0010	9994	2855	0006	9997	4642	0003	9999	7728	0001	2
3	9990	1608	0010	9994	2879	0006	9997	4679	0003	9999	7804	0001	3
4	9990	1627	0010	9994	2904	0006	9998	4717	0002	9999	7880	0001	4
5	9990	1645	0010	9994	2929	0006	9998	4754	0002	9999	7959	0001	5
6	9990	1664	0010	9994	2954	0006	9998	4792	0002	9999	8038	0001	6
7	9990	1683	0010	9995	2979	0005	9998	4830	0002	9999	8120	0001	7
8	9990	1701	0010	9995	3004	0005	9998	4869	0002	0.0000	8202	0000	8
9	9990	1720	0010	9995	3029	0005	9998	4908	0002	0.0000	8287	0000	9
10	9.9990	1.1739	0.0010	9.9995	1.3055	0.0005	9.9998	1.4947	0.0002	0.0000	1.8373	0.0000	10
11	9990	1758	0010	9995	3080	0005	9998	4987	0002	0000	8460	0000	11
12	9990	1777	0010	9995	3106	0005	9998	5027	0002	0000	8550	0000	12
13	9991	1796	0009	9995	3132	0005	9998	5068	0002	0000	8641	0000	13
14	9991	1815	0009	9995	3158	0005	9998	5108	0002	0000	8735	0000	14
15	9991	1835	0009	9995	3185	0005	9998	5150	0002	0000	8830	0000	15
16	9991	1854	0009	9995	3211	0005	9998	5191	0002	0000	8928	0000	16
17	9991	1874	0009	9995	3238	0005	9998	5233	0002	0000	9028	0000	17
18	9991	1893	0009	9995	3264	0005	9998	5275	0002	0000	9130	0000	18
19	9991	1913	0009	9995	3291	0005	9998	5318	0002	0000	9235	0000	19
20	9.9991	1.1933	0.0009	9.9995	1.3318	0.0005	9.9998	1.5362	0.0002	0.0000	1.9342	0.0000	20
21	9991	1953	0009	9995	3346	0005	9998	5405	0002	0000	9452	0000	21
22	9991	1972	0009	9995	3373	0005	9998	5449	0002	0000	9565	0000	22
23	9991	1992	0009	9995	3401	0005	9998	5494	0002	0000	9681	0000	23
24	9991	2012	0009	9996	3429	0004	9998	5539	0002	0000	9800	0000	24
25	9992	2033	0008	9996	3456	0004	9998	5584	0002	0000	9922	0000	25
26	9992	2053	0008	9996	3485	0004	9998	5630	0002	0000	2.0048	0000	26
27	9992	2073	0008	9996	3513	0004	9998	5677	0002	0000	2.0177	0000	27
28	9992	2094	0008	9996	3541	0004	9998	5724	0002	0000	2.0311	0000	28
29	9992	2114	0008	9996	3570	0004	9998	5771	0002	0000	2.0449	0000	29
30	9.9992	1.2135	0.0008	9.9996	1.3599	0.0004	9.9999	1.5819	0.0001	0.0000	2.0591	0.0000	30
31	9992	2156	0008	9996	3628	0004	9999	5868	0001	0000	0739	0000	31
32	9992	2177	0008	9996	3657	0004	9999	5917	0001	0000	0891	0000	32
33	9992	2198	0008	9996	3687	0004	9999	5967	0001	0000	1049	0000	33
34	9992	2219	0008	9996	3717	0004	9999	6017	0001	0000	1213	0000	34
35	9992	2240	0008	9996	3746	0004	9999	6068	0001	0000	1383	0000	35
36	9992	2261	0008	9996	3777	0004	9999	6119	0001	0000	1561	0000	36
37	9992	2283	0008	9996	3807	0004	9999	6171	0001	0000	1745	0000	37
38	9993	2304	0007	9996	3837	0004	9999	6224	0001	0000	1938	0000	38
39	9993	2326	0007	9996	3868	0004	9999	6277	0001	0000	2140	0000	39
40	9.9993	1.2348	0.0007	9.9996	1.3899	0.0004	9.9999	1.6331	0.0001	0.0000	2.2352	0.0000	40
41	9993	2369	0007	9996	3930	0004	9999	6386	0001	0000	2575	0000	41
42	9993	2391	0007	9997	3962	0003	9999	6441	0001	0000	2810	0000	42
43	9993	2413	0007	9997	3993	0003	9999	6497	0001	0000	3058	0000	43
44	9993	2435	0007	9997	4025	0003	9999	6554	0001	0000	3322	0000	44
45	9993	2458	0007	9997	4057	0003	9999	6611	0001	0000	3602	0000	45
46	9993	2480	0007	9997	4089	0003	9999	6670	0001	0000	3901	0000	46
47	9993	2503	0007	9997	4122	0003	9999	6729	0001	0000	4223	0000	47
48	9993	2525	0007	9997	4155	0003	9999	6789	0001	0000	4571	0000	48
49	9993	2548	0007	9997	4188	0003	9999	6850	0001	0000	4949	0000	49
50	9.9993	1.2571	0.0007	9.9997	1.4221	0.0003	9.9999	1.6911	0.0001	0.0000	2.5363	0.0000	50
51	9993	2594	0007	9997	4255	0003	9999	6974	0001	0000	5820	0000	51
52	9994	2617	0006	9997	4289	0003	9999	7037	0001	0000	6332	0000	52
53	9994	2640	0006	9997	4323	0003	9999	7101	0001	0000	6912	0000	53
54	9994	2663	0006	9997	4357	0003	9999	7167	0001	0000	7581	0000	54
55	9994	2687	0006	9997	4392	0003	9999	7233	0001	0000	8373	0000	55
56	9994	2710	0006	9997	4427	0003	9999	7300	0001	0000	9342	0000	56
57	9994	2734	0006	9997	4462	0003	9999	7369	0001	0000	3.0592	0000	57
58	9994	2758	0006	9997	4497	0003	9999	7438	0001	0000	3.2352	0000	58
59	9994	2782	0006	9997	4533	0003	9999	7509	0001	0000	3.5363	0000	59

TABLE X.

Proportional Logarithms to 3 Degrees, or 3 Hours.

	0 Degree, or 0 Hour.												
″	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	″
0		2.2553	1.9542	1.7782	1.6532	1.5563	1.4771	1.4102	1.3522	1.3010	1.2553	1.2139	0
1	4.0334	2.2481	1.9506	1.7757	1.6514	1.5549	1.4759	1.4091	1.3513	1.3002	1.2545	1.2132	1
2	3.7324	2.2410	1.9471	1.7734	1.6496	1.5534	1.4747	1.4081	1.3504	1.2994	1.2538	1.2126	2
3	3.5563	2.2341	1.9435	1.7710	1.6478	1.5520	1.4735	1.4071	1.3495	1.2986	1.2531	1.2119	3
4	3.4314	2.2272	1.9400	1.7686	1.6460	1.5506	1.4723	1.4061	1.3486	1.2978	1.2524	1.2113	4
5	3.3345	2.2205	1.9365	1.7663	1.6443	1.5491	1.4711	1.4050	1.3477	1.2970	1.2517	1.2106	5
6	3.2553	2.2139	1.9331	1.7639	1.6425	1.5477	1.4699	1.4040	1.3468	1.2962	1.2510	1.2099	6
7	3.1883	2.2073	1.9296	1.7616	1.6407	1.5463	1.4688	1.4030	1.3459	1.2954	1.2502	1.2093	7
8	3.1303	2.2009	1.9262	1.7593	1.6390	1.5449	1.4676	1.4020	1.3450	1.2946	1.2495	1.2086	8
9	3.0792	2.1946	1.9228	1.7570	1.6372	1.5435	1.4664	1.4010	1.3441	1.2939	1.2488	1.2080	9
10	3.0334	2.1883	1.9195	1.7547	1.6355	1.5421	1.4652	1.4000	1.3432	1.2931	1.2481	1.2073	10
11	2.9920	2.1822	1.9162	1.7524	1.6338	1.5407	1.4640	1.3989	1.3423	1.2923	1.2474	1.2067	11
12	2.9542	2.1761	1.9128	1.7501	1.6320	1.5393	1.4629	1.3979	1.3415	1.2915	1.2467	1.2061	12
13	2.9195	2.1701	1.9096	1.7479	1.6303	1.5379	1.4617	1.3969	1.3406	1.2907	1.2460	1.2054	13
14	2.8873	2.1642	1.9063	1.7456	1.6286	1.5365	1.4606	1.3959	1.3397	1.2899	1.2453	1.2048	14
15	2.8573	2.1584	1.9031	1.7434	1.6269	1.5351	1.4594	1.3949	1.3388	1.2891	1.2445	1.2041	15
16	2.8293	2.1526	1.8999	1.7412	1.6252	1.5337	1.4582	1.3939	1.3379	1.2883	1.2438	1.2035	16
17	2.8030	2.1469	1.8967	1.7390	1.6235	1.5324	1.4571	1.3929	1.3371	1.2876	1.2431	1.2028	17
18	2.7782	2.1413	1.8935	1.7368	1.6218	1.5310	1.4559	1.3919	1.3362	1.2868	1.2424	1.2022	18
19	2.7547	2.1358	1.8904	1.7346	1.6201	1.5296	1.4548	1.3910	1.3353	1.2860	1.2417	1.2016	19
20	2.7324	2.1303	1.8873	1.7324	1.6185	1.5283	1.4536	1.3900	1.3345	1.2852	1.2410	1.2009	20
21	2.7112	2.1249	1.8842	1.7302	1.6168	1.5269	1.4525	1.3890	1.3336	1.2845	1.2403	1.2003	21
22	2.6910	2.1196	1.8811	1.7281	1.6151	1.5256	1.4514	1.3880	1.3327	1.2837	1.2396	1.1996	22
23	2.6717	2.1143	1.8781	1.7259	1.6135	1.5242	1.4502	1.3870	1.3319	1.2829	1.2389	1.1990	23
24	2.6532	2.1091	1.8751	1.7238	1.6118	1.5229	1.4491	1.3860	1.3310	1.2821	1.2382	1.1984	24
25	2.6355	2.1040	1.8721	1.7217	1.6102	1.5215	1.4480	1.3851	1.3301	1.2814	1.2375	1.1977	25
26	2.6185	2.0989	1.8691	1.7196	1.6085	1.5202	1.4468	1.3841	1.3293	1.2806	1.2368	1.1971	26
27	2.6021	2.0939	1.8661	1.7175	1.6069	1.5189	1.4457	1.3831	1.3284	1.2798	1.2362	1.1965	27
28	2.5863	2.0889	1.8632	1.7154	1.6053	1.5175	1.4446	1.3821	1.3276	1.2791	1.2355	1.1958	28
29	2.5710	2.0840	1.8602	1.7133	1.6037	1.5162	1.4435	1.3812	1.3267	1.2783	1.2348	1.1952	29
30	2.5563	2.0792	1.8573	1.7112	1.6021	1.5149	1.4424	1.3802	1.3259	1.2775	1.2341	1.1946	30
31	2.5421	2.0744	1.8544	1.7091	1.6005	1.5136	1.4412	1.3792	1.3250	1.2768	1.2334	1.1939	31
32	2.5283	2.0696	1.8516	1.7071	1.5989	1.5123	1.4401	1.3783	1.3242	1.2760	1.2327	1.1933	32
33	2.5149	2.0649	1.8487	1.7050	1.5973	1.5110	1.4390	1.3773	1.3233	1.2753	1.2320	1.1927	33
34	2.5019	2.0603	1.8459	1.7030	1.5957	1.5097	1.4379	1.3764	1.3225	1.2745	1.2313	1.1921	34
35	2.4894	2.0557	1.8431	1.7010	1.5941	1.5084	1.4368	1.3754	1.3216	1.2738	1.2307	1.1914	35
36	2.4771	2.0512	1.8403	1.6990	1.5925	1.5071	1.4357	1.3745	1.3208	1.2730	1.2300	1.1908	36
37	2.4652	2.0467	1.8375	1.6970	1.5909	1.5058	1.4346	1.3735	1.3199	1.2722	1.2293	1.1902	37
38	2.4536	2.0422	1.8348	1.6950	1.5894	1.5045	1.4335	1.3726	1.3191	1.2715	1.2286	1.1896	38
39	2.4424	2.0378	1.8320	1.6930	1.5878	1.5032	1.4325	1.3716	1.3183	1.2707	1.2279	1.1889	39
40	2.4314	2.0334	1.8293	1.6910	1.5863	1.5019	1.4314	1.3707	1.3174	1.2700	1.2272	1.1883	40
41	2.4206	2.0291	1.8266	1.6890	1.5847	1.5007	1.4303	1.3697	1.3166	1.2692	1.2266	1.1877	41
42	2.4102	2.0248	1.8239	1.6871	1.5832	1.4994	1.4292	1.3688	1.3158	1.2685	1.2259	1.1871	42
43	2.4000	2.0206	1.8212	1.6851	1.5816	1.4981	1.4281	1.3678	1.3149	1.2678	1.2252	1.1865	43
44	2.3900	2.0164	1.8186	1.6832	1.5801	1.4969	1.4270	1.3669	1.3141	1.2670	1.2245	1.1858	44
45	2.3802	2.0122	1.8159	1.6812	1.5786	1.4956	1.4260	1.3660	1.3133	1.2663	1.2239	1.1852	45
46	2.3707	2.0081	1.8133	1.6793	1.5771	1.4943	1.4249	1.3650	1.3124	1.2655	1.2232	1.1846	46
47	2.3613	2.0040	1.8107	1.6774	1.5755	1.4931	1.4238	1.3641	1.3116	1.2648	1.2225	1.1840	47
48	2.3522	2.0000	1.8081	1.6755	1.5740	1.4918	1.4228	1.3632	1.3108	1.2640	1.2218	1.1834	48
49	2.3432	1.9960	1.8055	1.6736	1.5725	1.4906	1.4217	1.3623	1.3100	1.2633	1.2212	1.1828	49
50	2.3345	1.9920	1.8030	1.6717	1.5710	1.4894	1.4206	1.3613	1.3091	1.2626	1.2205	1.1822	50
51	2.3259	1.9881	1.8004	1.6698	1.5695	1.4881	1.4196	1.3604	1.3083	1.2618	1.2198	1.1816	51
52	2.3174	1.9842	1.7979	1.6679	1.5680	1.4869	1.4185	1.3595	1.3075	1.2611	1.2192	1.1809	52
53	2.3091	1.9803	1.7954	1.6661	1.5666	1.4856	1.4175	1.3586	1.3067	1.2604	1.2185	1.1803	53
54	2.3010	1.9765	1.7929	1.6642	1.5651	1.4844	1.4164	1.3576	1.3059	1.2596	1.2178	1.1797	54
55	2.2931	1.9727	1.7904	1.6624	1.5636	1.4832	1.4154	1.3567	1.3051	1.2589	1.2172	1.1791	55
56	2.2852	1.9690	1.7879	1.6605	1.5621	1.4820	1.4143	1.3558	1.3043	1.2582	1.2165	1.1785	56
57	2.2775	1.9652	1.7855	1.6587	1.5607	1.4808	1.4133	1.3549	1.3034	1.2574	1.2159	1.1779	57
58	2.2700	1.9615	1.7830	1.6568	1.5592	1.4795	1.4122	1.3540	1.3026	1.2567	1.2152	1.1773	58
59	2.2626	1.9579	1.7806	1.6550	1.5578	1.4783	1.4112	1.3531	1.3018	1.2560	1.2145	1.1767	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	0 Degree, or 0 Hour.												
″	12′	13′	14′	15′	16′	17′	18′	19′	20′	21′	22′	23′	″
0	1.1761	1.1413	1.1091	1 0792	1.0512	1.0248	1.0000	0.9765	0.9542	0.9331	0.9128	0.8935	0
1	1755	1408	1086	0787	0507	0244	0.9996	9761	9539	9327	9125	8932	1
2	1749	1402	1081	0782	0502	0240	0.9992	9758	9535	9324	9122	8929	2
3	1743	1397	1076	0777	0498	0235	0.9988	9754	9532	9320	9119	8926	3
4	1737	1391	1071	0773	0493	0231	0.9984	9750	9528	9317	9115	8923	4
5	1731	1386	1066	0768	0489	0227	0.9980	9746	9524	9313	9112	8920	5
6	1725	1380	1061	0763	0484	0223	0.9976	9742	9521	9310	9109	8917	6
7	1719	1374	1055	0758	0480	0219	0.9972	9739	9517	9306	9106	8913	7
8	1713	1369	1050	0753	0475	0214	0.9968	9735	9514	9303	9103	8910	8
9	1707	1363	1045	0749	0471	0210	0.9964	9731	9510	9300	9099	8907	9
10	1.1701	1.1358	1.1040	1.0744	1.0467	1.0206	0.9960	0.9727	0.9506	0.9296	0.9096	0.8904	10
11	1695	1352	1035	0739	0462	0202	9956	9723	9503	9293	9092	8901	11
12	1689	1347	1030	0734	0458	0197	9952	9720	9499	9289	9089	8898	12
13	1683	1342	1025	0730	0453	0193	9948	9716	9496	9286	9086	8895	13
14	1677	1336	1020	0725	0449	0189	9944	9712	9492	9283	9083	8892	14
15	1671	1331	1015	0720	0444	0185	9940	9708	9488	9279	9079	8888	15
16	1665	1325	1009	0715	0440	0181	9936	9705	9485	9276	9076	8885	16
17	1660	1320	1004	0711	0435	0176	9932	9701	9481	9272	9073	8882	17
18	1654	1314	0999	0706	0431	0172	9928	9697	9478	9269	9070	8879	18
19	1648	1309	0994	0701	0426	0168	9924	9693	9474	9266	9066	8876	19
20	1.1642	1.1303	1.0989	1.0696	1.0422	1.0164	0.9920	0.9690	0.9471	0.9262	0.9063	0.8873	20
21	1636	1298	0984	0692	0418	0160	9916	9686	9467	9259	9060	8870	21
22	1630	1292	0979	0687	0413	0156	9912	9682	9464	9255	9057	8867	22
23	1624	1287	0974	0682	0409	0151	9908	9678	9460	9252	9053	8864	23
24	1619	1282	0969	0678	0404	0147	9905	9675	9456	9249	9050	8861	24
25	1613	1276	0964	0673	0400	0143	9901	9671	9453	9245	9047	8857	25
26	1607	1271	0959	0668	0395	0139	9897	9667	9449	9242	9044	8854	26
27	1601	1266	0954	0663	0391	0135	9893	9664	9446	9238	9041	8851	27
28	1595	1260	0949	0659	0387	0131	9889	9660	9442	9235	9037	8848	28
29	1589	1255	0944	0654	0382	0126	9885	9656	9439	9232	9034	8845	29
30	1.1584	1.1249	1.0939	1.0649	1.0378	1.0122	0.9881	0.9652	0.9435	0.9228	0.9031	0.8842	30
31	1578	1244	0934	0645	0374	0118	9877	9649	9432	9225	9028	8839	31
32	1572	1239	0929	0640	0369	0114	9873	9645	9428	9222	9024	8836	32
33	1566	1233	0924	0635	0365	0110	9869	9641	9425	9218	9021	8833	33
34	1561	1228	0919	0631	0360	0106	9865	9638	9421	9215	9018	8830	34
35	1555	1223	0914	0626	0356	0102	9861	9634	9418	9212	9015	8827	35
36	1549	1217	0909	0621	0352	0098	9858	9630	9414	9208	9012	8824	36
37	1543	1212	0904	0617	0347	0093	9854	9626	9411	9205	9008	8821	37
38	1538	1207	0899	0612	0343	0089	9850	9623	9407	9201	9005	8817	38
39	1532	1201	0894	0608	0339	0085	9846	9619	9404	9198	9002	8814	39
40	1.1526	1.1196	1.0889	1.0603	1.0334	1.0081	0.9842	0.9615	0.9400	0.9195	0.8999	0.8811	40
41	1520	1191	0884	0598	0330	0077	9838	9612	9397	9191	8996	8808	41
42	1515	1186	0880	0594	0326	0073	9834	9608	9393	9188	8992	8805	42
43	1509	1180	0875	0589	0321	0069	9830	9604	9390	9185	8989	8802	43
44	1503	1175	0870	0585	0317	0065	9827	9601	9386	9181	8986	8799	44
45	1498	1170	0865	0580	0313	0061	9823	9597	9383	9178	8983	8796	45
46	1492	1164	0860	0575	0308	0057	9819	9593	9379	9175	8980	8793	46
47	1486	1159	0855	0571	0304	0053	9815	9590	9376	9172	8977	8790	47
48	1481	1154	0850	0566	0300	0049	9811	9586	9372	9168	8973	8787	48
49	1475	1149	0845	0562	0295	0044	9807	9582	9369	9165	8970	8784	49
50	1.1469	1.1143	1.0840	1.0557	1.0291	1.0040	0.9803	0.9579	0.9365	0.9162	0.8967	0.8781	50
51	1464	1138	0835	0552	0287	0036	9800	9575	9362	9158	8964	8778	51
52	1458	1133	0831	0548	0282	0032	9796	9571	9358	9155	8961	8775	52
53	1452	1128	0826	0543	0278	0028	9792	9568	9355	9152	8958	8772	53
54	1447	1123	0821	0539	0274	0024	9788	9564	9351	9148	8954	8769	54
55	1441	1117	0816	0534	0270	0020	9784	9561	9348	9145	8951	8766	55
56	1436	1112	0811	0530	0265	0016	9780	9557	9344	9142	8948	8763	56
57	1430	1107	0806	0525	0261	0012	9777	9553	9341	9138	8945	8760	57
58	1424	1102	0801	0521	0257	0008	9773	9550	9337	9135	8942	8757	58
59	1419	1097	0797	0516	0252	0004	9769	9546	9334	9132	8939	8754	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

′	0 Degree, or 0 Hour.												
″	24′	25′	26′	27′	28′	29′	30′	31′	32′	33′	34′	35′	″
0	8751	8573	8403	8239	8081	7929	7782	7639	7501	7368	7238	7112	0
1	8748	8570	8400	8236	8079	7926	7779	7637	7499	7365	7236	7110	1
2	8745	8568	8397	8234	8076	7924	7777	7634	7497	7363	7234	7108	2
3	8742	8565	8395	8231	8073	7921	7774	7632	7494	7361	7232	7106	3
4	8739	8562	8392	8228	8071	7919	7772	7630	7492	7359	7229	7104	4
5	8736	8559	8389	8226	8068	7916	7770	7627	7490	7357	7227	7102	5
6	8733	8556	8386	8223	8066	7914	7767	7625	7488	7354	7225	7100	6
7	8730	8553	8384	8220	8063	7911	7765	7623	7485	7352	7223	7098	7
8	8727	8550	8381	8218	8061	7909	7762	7621	7483	7350	7221	7096	8
9	8724	8547	8378	8215	8058	7906	7760	7618	7481	7348	7219	7094	9
10	8721	8545	8375	8212	8055	7904	7758	7616	7479	7346	7217	7091	10
11	8718	8542	8373	8210	8053	7901	7755	7614	7476	7344	7215	7089	11
12	8715	8539	8370	8207	8050	7899	7753	7611	7474	7341	7213	7087	12
13	8712	8536	8367	8204	8048	7896	7750	7609	7472	7339	7210	7085	13
14	8709	8533	8364	8202	8045	7894	7748	7607	7470	7337	7208	7083	14
15	8706	8530	8361	8199	8043	7892	7746	7604	7467	7335	7206	7081	15
16	8703	8527	8359	8196	8040	7889	7743	7602	7465	7333	7204	7079	16
17	8700	8524	8356	8194	8037	7887	7741	7600	7463	7331	7202	7077	17
18	8697	8522	8353	8191	8035	7884	7738	7597	7461	7328	7200	7075	18
19	8694	8519	8350	8188	8032	7882	7736	7595	7459	7326	7198	7073	19
20	8691	8516	8348	8186	8030	7879	7734	7593	7456	7324	7196	7071	20
21	8688	8513	8345	8183	8027	7877	7731	7590	7454	7322	7194	7069	21
22	8685	8510	8342	8181	8025	7874	7729	7588	7452	7320	7191	7067	22
23	8682	8507	8339	8178	8022	7872	7726	7586	7450	7317	7189	7065	23
24	8679	8504	8337	8175	8020	7869	7724	7583	7447	7315	7187	7063	24
25	8676	8502	8334	8173	8017	7867	7722	7581	7445	7313	7185	7061	25
26	8673	8499	8331	8170	8014	7864	7719	7579	7443	7311	7183	7059	26
27	8670	8496	8329	8167	8012	7862	7717	7577	7441	7309	7181	7057	27
28	8667	8493	8326	8165	8009	7859	7715	7574	7438	7307	7179	7055	28
29	8664	8490	8323	8162	8007	7857	7712	7572	7436	7304	7177	7053	29
30	8661	8487	8320	8159	8004	7855	7710	7570	7434	7302	7175	7050	30
31	8658	8485	8318	8157	8002	7852	7707	7567	7432	7300	7172	7048	31
32	8655	8482	8315	8154	7999	7850	7705	7565	7429	7298	7170	7046	32
33	8652	8479	8312	8152	7997	7847	7703	7563	7427	7296	7168	7044	33
34	8649	8476	8309	8149	7994	7845	7700	7560	7425	7294	7166	7042	34
35	8646	8473	8307	8146	7992	7842	7698	7558	7423	7292	7164	7040	35
36	8643	8470	8304	8144	7990	7840	7696	7556	7421	7289	7162	7038	36
37	8640	8468	8301	8141	7987	7837	7693	7554	7418	7287	7160	7036	37
38	8638	8465	8299	8138	7984	7835	7691	7551	7416	7285	7158	7034	38
39	8635	8462	8296	8136	7982	7833	7688	7549	7414	7283	7156	7032	39
40	8632	8459	8293	8133	7979	7830	7686	7547	7412	7281	7154	7030	40
41	8629	8456	8290	8131	7976	7828	7684	7544	7410	7279	7152	7028	41
42	8626	8453	8288	8128	7974	7825	7681	7542	7407	7276	7149	7026	42
43	8623	8451	8285	8125	7971	7823	7679	7540	7405	7274	7147	7024	43
44	8620	8448	8282	8123	7969	7820	7677	7538	7403	7272	7145	7022	44
45	8617	8445	8280	8120	7966	7818	7674	7535	7401	7270	7143	7020	45
46	8614	8442	8277	8118	7964	7815	7672	7533	7398	7268	7141	7018	46
47	8611	8439	8274	8115	7961	7813	7670	7531	7396	7266	7139	7016	47
48	8608	8437	8271	8112	7959	7811	7667	7529	7394	7264	7137	7014	48
49	8605	8434	8269	8110	7956	7808	7665	7526	7392	7261	7135	7012	49
50	8602	8431	8266	8107	7954	7806	7663	7524	7390	7259	7133	7010	50
51	8600	8428	8263	8105	7951	7803	7660	7522	7387	7257	7131	7008	51
52	8597	8425	8261	8102	7949	7801	7658	7519	7385	7255	7129	7006	52
53	8594	8423	8258	8099	7946	7798	7656	7517	7383	7253	7127	7004	53
54	8591	8420	8255	8097	7944	7796	7653	7515	7381	7251	7125	7002	54
55	8588	8417	8253	8094	7941	7794	7651	7513	7379	7249	7122	7000	55
56	8585	8414	8250	8092	7939	7791	7649	7510	7376	7247	7120	6998	56
57	8582	8411	8247	8089	7936	7789	7646	7508	7374	7244	7118	6996	57
58	8579	8409	8245	8086	7934	7786	7644	7506	7372	7242	7116	6994	58
59	8576	8406	8242	8084	7931	7784	7641	7504	7370	7240	7114	6992	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	0 Degree, or 0 Hour.												
″	36′	37′	38′	39′	40′	41′	42′	43′	44′	45′	46′	47′	″
0	6990	6871	6755	6642	6532	6425	6320	6218	6118	6021	5925	5832	0
1	6988	6869	6753	6640	6530	6423	6319	6216	6117	6019	5924	5830	1
2	6986	6867	6751	6638	6529	6421	6317	6215	6115	6017	5922	5829	2
3	6984	6865	6749	6637	6527	6420	6315	6213	6113	6016	5920	5827	3
4	6982	6863	6747	6635	6525	6418	6313	6211	6112	6014	5919	5826	4
5	6980	6861	6745	6633	6523	6416	6312	6210	6110	6013	5917	5824	5
6	6978	6859	6744	6631	6521	6414	6310	6208	6108	6011	5916	5823	6
7	6976	6857	6742	6629	6520	6413	6308	6206	6107	6009	5914	5821	7
8	6974	6855	6740	6627	6518	6411	6307	6205	6105	6008	5913	5819	8
9	6972	6853	6738	6625	6516	6409	6305	6203	6103	6006	5911	5818	9
10	6970	6851	6736	6624	6514	6407	6303	6201	6102	6005	5909	5816	10
11	6968	6849	6734	6622	6512	6406	6301	6200	6100	6003	5908	5815	11
12	6966	6847	6732	6620	6511	6404	6300	6198	6099	6001	5906	5813	12
13	6964	6845	6730	6618	6509	6402	6298	6196	6097	6000	5905	5812	13
14	6962	6843	6728	6616	6507	6400	6296	6195	6095	5998	5903	5810	14
15	6960	6842	6726	6614	6505	6399	6295	6193	6094	5997	5902	5809	15
16	6958	6840	6725	6613	6503	6397	6293	6191	6092	5995	5900	5807	16
17	6956	6838	6723	6611	6502	6395	6291	6190	6090	5993	5899	5806	17
18	6954	6836	6721	6609	6500	6393	6289	6188	6089	5992	5897	5804	18
19	6952	6834	6719	6607	6498	6392	6288	6186	6087	5990	5895	5803	19
20	6950	6832	6717	6605	6496	6390	6286	6185	6085	5989	5894	5801	20
21	6948	6830	6715	6603	6494	6388	6284	6183	6084	5987	5892	5800	21
22	6946	6828	6713	6601	6493	6386	6283	6181	6082	5985	5891	5798	22
23	6944	6826	6711	6600	6491	6385	6281	6180	6081	5984	5889	5797	23
24	6942	6824	6709	6598	6489	6383	6279	6178	6079	5982	5888	5795	24
25	6940	6822	6708	6596	6487	6381	6277	6176	6077	5981	5886	5793	25
26	6938	6820	6706	6594	6485	6379	6276	6175	6076	5979	5884	5792	26
27	6936	6818	6704	6592	6484	6378	6274	6173	6074	5977	5883	5790	27
28	6934	6816	6702	6590	6482	6376	6272	6171	6072	5976	5881	5789	28
29	6932	6814	6700	6589	6480	6374	6271	6170	6071	5974	5880	5787	29
30	6930	6812	6698	6587	6478	6372	6269	6168	6069	5973	5878	5786	30
31	6928	6811	6696	6585	6476	6371	6267	6166	6068	5971	5877	5784	31
32	6926	6809	6694	6583	6475	6369	6265	6165	6066	5969	5875	5783	32
33	6924	6807	6693	6581	6473	6367	6264	6163	6064	5968	5874	5781	33
34	6922	6805	6691	6579	6471	6365	6262	6161	6063	5966	5872	5780	34
35	6920	6803	6689	6578	6469	6364	6260	6160	6061	5965	5870	5778	35
36	6918	6801	6687	6576	6468	6362	6259	6158	6059	5963	5869	5777	36
37	6916	6799	6685	6574	6466	6360	6257	6156	6058	5962	5867	5775	37
38	6914	6797	6683	6572	6464	6358	6255	6155	6056	5960	5866	5774	38
39	6912	6795	6681	6570	6462	6357	6254	6153	6055	5958	5864	5772	39
40	6910	6793	6679	6569	6460	6355	6252	6151	6053	5957	5863	5771	40
41	6908	6791	6678	6567	6459	6353	6250	6150	6051	5955	5861	5769	41
42	6906	6789	6676	6565	6457	6351	6249	6148	6050	5954	5860	5768	42
43	6904	6787	6674	6563	6455	6350	6247	6146	6048	5952	5858	5766	43
44	6902	6786	6672	6561	6453	6348	6245	6145	6046	5950	5857	5765	44
45	6900	6784	6670	6559	6451	6346	6243	6143	6045	5949	5855	5763	45
46	6898	6782	6668	6558	6450	6344	6242	6141	6043	5947	5853	5762	46
47	6896	6780	6666	6556	6448	6343	6240	6140	6042	5946	5852	5760	47
48	6894	6778	6664	6554	6446	6341	6238	6138	6040	5944	5850	5758	48
49	6892	6776	6663	6552	6444	6339	6237	6136	6038	5943	5849	5757	49
50	6890	6774	6661	6550	6443	6338	6235	6135	6037	5941	5847	5755	50
51	6888	6772	6659	6548	6141	6336	6233	6133	6035	5939	5846	5754	51
52	6886	6770	6657	6547	6439	6334	6232	6131	6034	5938	5844	5752	52
53	6884	6768	6655	6545	6437	6332	6230	6130	6032	5936	5843	5751	53
54	6883	6766	6653	6543	6436	6331	6228	6128	6030	5935	5841	5749	54
55	6881	6764	6651	6541	6434	6329	6227	6126	6029	5933	5840	5748	55
56	6879	6763	6650	6539	6432	6327	6225	6125	6027	5931	5838	5746	56
57	6877	6761	6648	6538	6430	6325	6223	6123	6025	5930	5836	5745	57
58	6875	6759	6646	6536	6428	6324	6221	6122	6024	5928	5835	5743	58
59	6873	6757	6644	6534	6427	6322	6220	6120	6022	5927	5833	5742	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	0 Degree, or 0 Hour.												
″	48′	49′	50′	51′	52′	53′	54′	55′	56′	57′	58′	59′	″
0	5740	5651	5563	5477	5393	5310	5229	5149	5071	4994	4918	4844	0
1	5739	5649	5562	5476	5391	5309	5227	5148	5070	4993	4917	4843	1
2	5737	5648	5560	5474	5390	5307	5226	5147	5068	4991	4916	4842	2
3	5736	5646	5559	5473	5389	5306	5225	5145	5067	4990	4915	4841	3
4	5734	5645	5557	5471	5387	5305	5223	5144	5066	4989	4914	4839	4
5	5733	5643	5556	5470	5386	5303	5222	5143	5064	4988	4912	4838	5
6	5731	5642	5554	5469	5384	5302	5221	5141	5063	4986	4911	4837	6
7	5730	5640	5553	5467	5383	5300	5219	5140	5062	4985	4910	4836	7
8	5728	5639	5552	5466	5382	5299	5218	5139	5061	4984	4909	4834	8
9	5727	5638	5550	5464	5380	5298	5217	5137	5059	4983	4907	4833	9
10	5725	5636	5549	5463	5379	5296	5215	5136	5058	4981	4906	4832	10
11	5724	5635	5547	5461	5377	5295	5214	5135	5057	4980	4905	4831	11
12	5722	5633	5546	5460	5376	5294	5213	5133	5055	4979	4904	4830	12
13	5721	5632	5544	5459	5375	5292	5211	5132	5054	4978	4902	4828	13
14	5719	5630	5543	5457	5373	5291	5210	5131	5053	4976	4901	4827	14
15	5718	5629	5541	5456	5372	5290	5209	5129	5052	4975	4900	4826	15
16	5716	5627	5540	5454	5371	5288	5207	5128	5050	4974	4899	4825	16
17	5715	5626	5539	5453	5369	5287	5206	5127	5049	4972	4897	4823	17
18	5713	5624	5537	5452	5368	5286	5205	5126	5048	4971	4896	4822	18
19	5712	5623	5536	5450	5366	5284	5203	5124	5046	4970	4895	4821	19
20	5710	5621	5534	5449	5365	5283	5202	5123	5045	4969	4894	4820	20
21	5709	5620	5533	5447	5364	5281	5201	5122	5044	4967	4892	4819	21
22	5707	5618	5531	5446	5362	5280	5199	5120	5043	4966	4891	4817	22
23	5706	5617	5530	5445	5361	5279	5198	5119	5041	4965	4890	4816	23
24	5704	5616	5528	5443	5359	5277	5197	5118	5040	4964	4889	4815	24
25	5703	5614	5527	5442	5358	5276	5195	5116	5039	4962	4887	4814	25
26	5701	5613	5526	5440	5357	5275	5194	5115	5037	4961	4886	4812	26
27	5700	5611	5524	5439	5355	5273	5193	5114	5036	4960	4885	4811	27
28	5698	5610	5523	5438	5354	5272	5191	5112	5035	4959	4884	4810	28
29	5697	5608	5521	5436	5353	5271	5190	5111	5034	4957	4882	4809	29
30	5695	5607	5520	5435	5351	5269	5189	5110	5032	4956	4881	4808	30
31	5694	5605	5518	5433	5350	5268	5187	5109	5031	4955	4880	4806	31
32	5692	5604	5517	5432	5348	5267	5186	5107	5030	4954	4879	4805	32
33	5691	5602	5516	5430	5347	5265	5185	5106	5028	4952	4878	4804	33
34	5689	5601	5514	5429	5346	5264	5184	5105	5027	4951	4876	4803	34
35	5688	5599	5513	5428	5344	5262	5182	5103	5026	4950	4875	4802	35
36	5686	5598	5511	5426	5343	5261	5181	5102	5025	4949	4874	4800	36
37	5685	5596	5510	5425	5342	5260	5180	5101	5023	4947	4873	4799	37
38	5683	5595	5508	5423	5340	5258	5178	5099	5022	4946	4871	4798	38
39	5682	5594	5507	5422	5339	5257	5177	5098	5021	4945	4870	4797	39
40	5680	5592	5506	5421	5337	5256	5176	5097	5019	4944	4869	4795	40
41	5679	5591	5504	5419	5336	5254	5174	5096	5018	4942	4868	4794	41
42	5677	5589	5503	5418	5335	5253	5173	5094	5017	4941	4866	4793	42
43	5676	5588	5501	5416	5333	5252	5172	5093	5016	4940	4865	4792	43
44	5675	5586	5500	5415	5332	5250	5170	5092	5014	4939	4864	4791	44
45	5673	5585	5498	5414	5331	5249	5169	5090	5013	4937	4863	4789	45
46	5672	5583	5497	5412	5329	5248	5168	5089	5012	4936	4861	4788	46
47	5670	5582	5496	5411	5328	5246	5166	5088	5011	4935	4860	4787	47
48	5669	5580	5494	5409	5326	5245	5165	5086	5009	4933	4859	4786	48
49	5667	5579	5493	5408	5325	5244	5164	5085	5008	4932	4858	4785	49
50	5666	5578	5491	5407	5324	5242	5162	5084	5007	4931	4857	4783	50
51	5664	5576	5490	5405	5322	5241	5161	5083	5005	4930	4855	4782	51
52	5663	5575	5488	5404	5321	5240	5160	5081	5004	4928	4854	4781	52
53	5661	5573	5487	5402	5320	5238	5158	5080	5003	4927	4853	4780	53
54	5660	5572	5486	5401	5318	5237	5157	5079	5002	4926	4852	4779	54
55	5658	5570	5484	5400	5317	5236	5156	5077	5000	4925	4850	4777	55
56	5657	5569	5483	5398	5315	5234	5154	5076	4999	4923	4849	4776	56
57	5655	5567	5481	5397	5314	5233	5153	5075	4998	4922	4848	4775	57
58	5654	5566	5480	5396	5313	5232	5152	5073	4997	4921	4847	4774	58
59	5652	5565	5478	5394	5311	5230	5150	5072	4995	4920	4845	4772	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	1 Degree, or 1 Hour.															
″	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	12′	13′	14′	″
0	4771	4699	4629	4559	4491	4424	4357	4292	4228	4164	4102	4040	3979	3919	3860	0
1	4770	4698	4628	4558	4490	4422	4356	4291	4227	4163	4101	4039	3978	3919	3859	1
2	4769	4697	4626	4557	4489	4421	4355	4290	4226	4162	4100	4038	3977	3918	3858	2
3	4768	4696	4625	4556	4488	4420	4354	4289	4224	4161	4099	4037	3976	3917	3858	3
4	4766	4695	4624	4555	4486	4419	4353	4288	4223	4160	4098	4036	3975	3916	3856	4
5	4765	4693	4623	4554	4485	4418	4352	4287	4222	4159	4097	4035	3974	3915	3856	5
6	4764	4692	4622	4552	4484	4417	4351	4285	4221	4158	4096	4034	3973	3914	3855	6
7	4763	4691	4621	4551	4483	4416	4350	4284	4220	4157	4095	4033	3972	3913	3854	7
8	4762	4690	4619	4550	4482	4415	4349	4283	4219	4156	4093	4032	3971	3912	3853	8
9	4760	4689	4618	4549	4481	4414	4347	4282	4218	4155	4092	4031	3970	3911	3852	9
10	4759	4688	4617	4548	4480	4412	4346	4281	4217	4154	4091	4030	3969	3910	3851	10
11	4758	4686	4616	4547	4479	4411	4345	4280	4216	4153	4090	4029	3968	3909	3850	11
12	4757	4685	4615	4546	4477	4410	4344	4279	4215	4152	4089	4028	3967	3908	3849	12
13	4756	4684	4614	4544	4476	4409	4343	4278	4214	4151	4088	4027	3966	3907	3848	13
14	4754	4683	4612	4543	4475	4408	4342	4277	4213	4150	4087	4026	3965	3906	3847	14
15	4753	4682	4611	4542	4474	4407	4341	4276	4212	4149	4086	4025	3964	3905	3846	15
16	4752	4680	4610	4541	4473	4406	4340	4275	4211	4147	4085	4024	3963	3904	3845	16
17	4751	4679	4609	4540	4472	4405	4339	4274	4210	4146	4084	4023	3962	3903	3844	17
18	4750	4678	4608	4539	4471	4404	4338	4273	4209	4145	4083	4022	3961	3902	3843	18
19	4748	4677	4607	4538	4469	4402	4336	4272	4207	4144	4082	4021	3960	3901	3842	19
20	4747	4676	4606	4536	4468	4401	4335	4270	4206	4143	4081	4020	3959	3900	3841	20
21	4746	4675	4604	4535	4467	4400	4334	4269	4205	4142	4080	4019	3958	3899	3840	21
22	4745	4673	4603	4534	4466	4399	4333	4268	4204	4141	4079	4018	3957	3898	3839	22
23	4744	4672	4602	4533	4465	4398	4332	4267	4203	4140	4078	4017	3956	3897	3838	23
24	4742	4671	4601	4532	4464	4397	4331	4266	4202	4139	4077	4016	3955	3896	3837	24
25	4741	4670	4600	4531	4463	4396	4330	4265	4201	4138	4076	4015	3954	3895	3836	25
26	4740	4669	4599	4530	4462	4395	4329	4264	4200	4137	4075	4014	3953	3894	3835	26
27	4739	4668	4597	4528	4460	4394	4328	4263	4199	4136	4074	4013	3952	3893	3834	27
28	4738	4666	4596	4527	4459	4393	4327	4262	4198	4135	4073	4012	3951	3892	3833	28
29	4736	4665	4595	4526	4458	4391	4326	4261	4197	4134	4072	4011	3950	3891	3832	29
30	4735	4664	4594	4525	4457	4390	4325	4260	4196	4133	4071	4010	3949	3890	3831	30
31	4734	4663	4593	4524	4456	4389	4323	4259	4195	4132	4070	4009	3948	3889	3830	31
32	4733	4662	4592	4523	4455	4388	4322	4258	4194	4131	4069	4008	3947	3888	3829	32
33	4732	4660	4590	4522	4454	4387	4321	4256	4193	4130	4068	4007	3946	3887	3828	33
34	4730	4659	4589	4520	4453	4386	4320	4255	4192	4129	4067	4006	3945	3886	3827	34
35	4729	4658	4588	4519	4452	4385	4319	4254	4191	4128	4066	4005	3944	3885	3826	35
36	4728	4657	4587	4518	4450	4384	4318	4253	4189	4127	4065	4004	3943	3884	3825	36
37	4727	4656	4586	4517	4449	4383	4317	4252	4198	4126	4064	4003	3942	3883	3824	37
38	4726	4655	4585	4516	4448	4381	4316	4251	4187	4125	4063	4002	3941	3882	3823	38
39	4724	4653	4584	4515	4447	4380	4315	4250	4186	4124	4062	4001	3940	3881	3822	39
40	4723	4652	4582	4514	4446	4379	4314	4249	4185	4122	4061	4000	3939	3880	3821	40
41	4722	4651	4581	4512	4445	4378	4313	4248	4184	4121	4060	3999	3938	3879	3820	41
42	4721	4650	4580	4511	4444	4377	4311	4247	4183	4120	4059	3998	3937	3878	3820	42
43	4720	4649	4579	4510	4443	4376	4310	4246	4182	4119	4058	3997	3936	3877	3819	43
44	4718	4648	4578	4509	4441	4375	4309	4245	4181	4118	4057	3996	3935	3876	3818	44
45	4717	4646	4577	4508	4440	4374	4308	4244	4180	4117	4056	3995	3934	3875	3817	45
46	4716	4645	4575	4507	4439	4373	4307	4243	4179	4116	4054	3993	3933	3874	3816	46
47	4715	4644	4574	4506	4438	4372	4306	4241	4178	4115	4053	3992	3932	3873	3815	47
48	4714	4643	4573	4505	4437	4370	4305	4240	4177	4114	4052	3991	3931	3872	3814	48
49	4712	4642	4572	4503	4436	4369	4304	4239	4176	4113	4051	3990	3930	3871	3813	49
50	4711	4640	4571	4502	4435	4368	4303	4238	4175	4112	4050	3989	3929	3870	3812	50
51	4710	4639	4570	4501	4434	4367	4302	4237	4174	4111	4049	3988	3928	3869	3811	51
52	4709	4638	4569	4500	4433	4366	4301	4236	4173	4110	4048	3987	3927	3868	3810	52
53	4708	4637	4567	4499	4431	4365	4300	4235	4172	4109	4047	3986	3926	3867	3809	53
54	4707	4636	4566	4498	4430	4364	4298	4234	4171	4108	4046	3985	3925	3866	3808	54
55	4705	4635	4565	4497	4429	4363	4297	4233	4169	4107	4045	3984	3924	3865	3807	55
56	4704	4633	4564	4495	4428	4362	4296	4232	4168	4106	4044	3983	3923	3864	3806	56
57	4703	4632	4563	4494	4427	4361	4295	4231	4167	4105	4043	3982	3922	3863	3805	57
58	4702	4631	4562	4493	4426	4359	4294	4230	4166	4104	4042	3981	3921	3862	3804	58
59	4701	4630	4560	4492	4425	4358	4293	4229	4165	4103	4041	3980	3920	3861	3803	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	1 Degree, or 1 Hour.															
″	15′	16′	17′	18′	19′	20′	21′	22′	23′	24′	25′	26′	27′	28′	29′	″
0	3802	3745	3688	3632	3576	3522	3468	3415	3362	3310	3259	3208	3158	3108	3059	0
1	3801	3744	3687	3631	3576	3521	3467	3414	3361	3309	3258	3207	3157	3107	3058	1
2	3800	3743	3686	3630	3575	3520	3466	3413	3360	3308	3257	3206	3156	3106	3057	2
3	3799	3742	3685	3629	3574	3519	3465	3412	3359	3307	3256	3205	3155	3105	3056	3
4	3798	3741	3684	3628	3573	3518	3464	3411	3359	3307	3255	3204	3154	3105	3056	4
5	3797	3740	3683	3627	3572	3517	3463	3410	3358	3306	3254	3204	3153	3104	3055	5
6	3796	3739	3682	3626	3571	3516	3463	3409	3357	3305	3253	3203	3153	3103	3054	6
7	3795	3738	3681	3625	3570	3516	3462	3408	3356	3304	3253	3202	3152	3102	3053	7
8	3794	3737	3680	3624	3569	3515	3461	3408	3355	3303	3252	3201	3151	3101	3052	8
9	3793	3736	3679	3623	3568	3514	3460	3407	3354	3302	3251	3200	3150	3101	3052	9
10	3793	3735	3678	3623	3567	3513	3459	3406	3353	3301	3250	3199	3149	3100	3051	10
11	3792	3734	3678	3622	3566	3512	3458	3405	3352	3301	3249	3199	3148	3099	3050	11
12	3791	3733	3677	3621	3566	3511	3457	3404	3352	3300	3248	3198	3148	3098	3049	12
13	3790	3732	3676	3620	3565	3510	3456	3403	3351	3299	3248	3197	3147	3097	3048	13
14	3789	3731	3675	3619	3564	3509	3455	3402	3350	3298	3247	3196	3146	3096	3048	14
15	3788	3730	3674	3618	3563	3508	3455	3401	3349	3297	3246	3195	3145	3096	3047	15
16	3787	3729	3673	3617	3562	3507	3454	3401	3348	3296	3245	3194	3144	3095	3046	16
17	3786	3728	3672	3616	3561	3507	3453	3400	3347	3295	3244	3194	3143	3094	3045	17
18	3785	3728	3671	3615	3560	3506	3452	3399	3346	3294	3243	3193	3143	3093	3044	18
19	3784	3727	3670	3614	3559	3505	3451	3398	3345	3294	3242	3192	3142	3092	3043	19
20	3783	3726	3669	3613	3558	3504	3450	3397	3345	3293	3242	3191	3141	3092	3043	20
21	3782	3725	3668	3612	3557	3503	3449	3396	3344	3292	3241	3190	3140	3091	3042	21
22	3781	3724	3667	3611	3556	3502	3448	3395	3343	3291	3240	3189	3139	3090	3041	22
23	3780	3723	3666	3611	3555	3501	3447	3394	3342	3290	3239	3188	3138	3089	3040	23
24	3779	3722	3665	3610	3555	3500	3447	3394	3341	3289	3238	3188	3138	3088	3039	24
25	3778	3721	3664	3609	3554	3499	3446	3393	3340	3288	3237	3187	3137	3087	3039	25
26	3777	3720	3663	3608	3553	3498	3445	3392	3339	3288	3237	3186	3136	3087	3038	26
27	3776	3719	3663	3607	3552	3498	3444	3391	3339	3287	3236	3185	3135	3086	3037	27
28	3775	3718	3662	3606	3551	3497	3443	3390	3338	3286	3235	3184	3134	3085	3036	28
29	3774	3717	3661	3605	3550	3496	3442	3389	3337	3285	3234	3183	3134	3084	3035	29
30	3773	3716	3660	3604	3549	3495	3441	3388	3336	3284	3233	3183	3133	3083	3035	30
31	3772	3715	3659	3603	3548	3494	3440	3387	3335	3283	3232	3182	3132	3083	3034	31
32	3771	3714	3658	3602	3547	3493	3439	3386	3334	3282	3231	3181	3131	3082	3033	32
33	3770	3713	3657	3601	3546	3492	3439	3386	3333	3282	3231	3180	3130	3081	3032	33
34	3769	3712	3656	3600	3545	3491	3438	3385	3332	3281	3230	3179	3129	3080	3031	34
35	3769	3711	3655	3599	3545	3490	3437	3384	3332	3280	3229	3178	3129	3079	3031	35
36	3768	3710	3654	3599	3544	3489	3436	3383	3331	3279	3228	3178	3128	3078	3030	36
37	3767	3710	3653	3598	3543	3489	3435	3382	3330	3278	3227	3177	3127	3078	3029	37
38	3766	3709	3652	3597	3542	3488	3434	3381	3329	3277	3226	3176	3126	3077	3028	38
39	3765	3708	3651	3596	3541	3487	3433	3380	3328	3277	3226	3175	3125	3076	3027	39
40	3764	3707	3650	3595	3540	3486	3432	3379	3327	3276	3225	3174	3124	3075	3026	40
41	3763	3706	3649	3594	3539	3485	3431	3379	3326	3275	3224	3173	3124	3074	3026	41
42	3762	3705	3649	3593	3538	3484	3431	3378	3326	3274	3223	3173	3123	3074	3025	42
43	3761	3704	3648	3592	3537	3483	3430	3377	3325	3273	3222	3172	3122	3073	3024	43
44	3760	3703	3647	3591	3536	3482	3429	3376	3324	3272	3221	3171	3121	3072	3023	44
45	3759	3702	3646	3590	3535	3481	3428	3375	3323	3271	3220	3170	3120	3071	3022	45
46	3758	3701	3645	3589	3535	3480	3427	3374	3322	3271	3220	3169	3119	3070	3022	46
47	3757	3700	3644	3588	3534	3480	3426	3373	3321	3270	3219	3168	3119	3069	3021	47
48	3756	3699	3643	3588	3533	3479	3425	3372	3320	3269	3218	3168	3118	3069	3020	48
49	3755	3698	3642	3587	3532	3478	3424	3372	3319	3268	3217	3167	3117	3068	3019	49
50	3754	3697	3641	3586	3531	3477	3423	3371	3319	3267	3216	3166	3116	3067	3018	50
51	3753	3696	3640	3585	3530	3476	3423	3370	3318	3266	3215	3165	3115	3066	3018	51
52	3752	3695	3639	3584	3529	3475	3422	3369	3317	3265	3215	3164	3115	3065	3017	52
53	3751	3694	3638	3583	3528	3474	3421	3368	3316	3265	3214	3163	3114	3065	3016	53
54	3750	3694	3637	3582	3527	3473	3420	3367	3315	3264	3213	3163	3113	3064	3015	54
55	3749	3693	3636	3581	3526	3472	3419	3366	3314	3263	3212	3162	3112	3063	3014	55
56	3748	3692	3636	3580	3525	3472	3418	3365	3313	3262	3211	3161	3111	3062	3014	56
57	3747	3691	3635	3579	3525	3471	3417	3365	3313	3261	3210	3160	3110	3061	3013	57
58	3747	3690	3634	3578	3524	3470	3416	3364	3312	3260	3209	3159	3110	3061	3012	58
59	3746	3689	3633	3577	3523	3469	3416	3363	3311	3259	3209	3158	3109	3060	3011	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	1 Degree, or 1 Hour.															
″	30′	31′	32′	33′	34′	35′	36′	37′	38′	39′	40′	41′	42′	43′	44′	″
0	3010	2962	2915	2868	2821	2775	2730	2685	2640	2596	2553	2510	2467	2424	2382	0
1	3010	2962	2914	2867	2821	2775	2729	2684	2640	2596	2552	2509	2466	2424	2382	1
2	3009	2961	2913	2866	2820	2774	2729	2684	2639	2595	2551	2508	2465	2423	2381	2
3	3008	2960	2913	2866	2819	2773	2728	2683	2638	2594	2551	2507	2465	2422	2380	3
4	3007	2959	2912	2865	2818	2772	2727	2682	2638	2593	2550	2507	2464	2422	2380	4
5	3006	2958	2911	2864	2818	2772	2726	2681	2637	2593	2549	2506	2463	2421	2379	5
6	3006	2958	2910	2863	2817	2771	2726	2681	2636	2592	2548	2505	2463	2420	2378	6
7	3005	2957	2909	2863	2816	2770	2725	2680	2635	2591	2548	2505	2462	2419	2378	7
8	3004	2956	2909	2862	2815	2769	2724	2679	2635	2591	2547	2504	2461	2419	2377	8
9	3003	2955	2908	2861	2815	2769	2723	2678	2634	2590	2546	2503	2460	2418	2376	9
10	3002	2954	2907	2860	2814	2768	2723	2678	2633	2589	2546	2502	2460	2417	2375	10
11	3002	2954	2906	2859	2813	2767	2722	2677	2632	2588	2545	2502	2459	2417	2375	11
12	3001	2953	2905	2859	2812	2766	2721	2676	2632	2588	2544	2501	2458	2416	2374	12
13	3000	2952	2905	2858	2811	2766	2720	2675	2631	2587	2543	2500	2458	2415	2373	13
14	2999	2951	2904	2857	2811	2765	2720	2675	2630	2586	2543	2500	2457	2415	2373	14
15	2998	2950	2903	2856	2810	2764	2719	2674	2629	2585	2542	2499	2456	2414	2372	15
16	2998	2950	2902	2856	2809	2763	2718	2673	2629	2585	2541	2498	2455	2413	2371	16
17	2997	2949	2902	2855	2808	2763	2717	2672	2628	2584	2540	2497	2455	2412	2371	17
18	2996	2948	2901	2854	2808	2762	2717	2672	2627	2583	2540	2497	2454	2412	2370	18
19	2995	2947	2900	2853	2807	2761	2716	2671	2627	2583	2539	2496	2453	2411	2369	19
20	2994	2946	2899	2852	2806	2760	2715	2670	2626	2582	2538	2495	2453	2410	2369	20
21	2993	2946	2898	2852	2805	2760	2714	2669	2625	2581	2538	2495	2452	2410	2368	21
22	2993	2945	2898	2851	2805	2759	2714	2669	2624	2580	2537	2494	2451	2409	2367	22
23	2992	2944	2897	2850	2804	2758	2713	2668	2624	2580	2536	2493	2450	2408	2366	23
24	2991	2943	2896	2849	2803	2757	2712	2667	2623	2579	2535	2492	2450	2408	2366	24
25	2990	2943	2895	2849	2802	2757	2711	2666	2622	2578	2535	2492	2449	2407	2365	25
26	2989	2942	2894	2848	2802	2756	2711	2666	2621	2577	2534	2491	2448	2406	2364	26
27	2989	2941	2894	2847	2801	2755	2710	2665	2621	2577	2533	2490	2448	2405	2364	27
28	2988	2940	2893	2846	2800	2754	2709	2664	2620	2576	2533	2490	2447	2405	2363	28
29	2987	2939	2892	2845	2799	2753	2708	2663	2619	2575	2532	2489	2446	2404	2362	29
30	2986	2939	2891	2845	2798	2753	2708	2663	2618	2575	2531	2488	2446	2403	2362	30
31	2985	2938	2891	2844	2798	2752	2707	2662	2618	2574	2530	2487	2445	2403	2361	31
32	2985	2937	2890	2843	2797	2751	2706	2661	2617	2573	2530	2487	2444	2402	2360	32
33	2984	2936	2889	2842	2796	2750	2705	2661	2616	2572	2529	2486	2443	2401	2360	33
34	2983	2935	2888	2842	2795	2750	2705	2660	2615	2572	2528	2485	2443	2401	2359	34
35	2982	2935	2887	2841	2795	2749	2704	2659	2615	2571	2528	2485	2442	2400	2358	35
36	2981	2934	2887	2840	2794	2748	2703	2658	2614	2570	2527	2484	2441	2399	2357	36
37	2981	2933	2886	2839	2793	2747	2702	2658	2613	2569	2526	2483	2441	2398	2357	37
38	2980	2932	2885	2838	2792	2747	2702	2657	2613	2569	2525	2482	2440	2398	2356	38
39	2979	2931	2884	2838	2792	2746	2701	2656	2612	2568	2525	2482	2439	2397	2355	39
40	2978	2931	2884	2837	2791	2745	2700	2655	2611	2567	2524	2481	2438	2396	2355	40
41	2978	2930	2883	2836	2790	2744	2699	2655	2610	2567	2523	2480	2438	2396	2354	41
42	2977	2929	2882	2835	2789	2744	2699	2654	2610	2566	2522	2480	2437	2395	2353	42
43	2976	2928	2881	2835	2789	2743	2698	2653	2609	2565	2522	2479	2436	2394	2353	43
44	2975	2928	2880	2834	2788	2742	2697	2652	2608	2564	2521	2478	2436	2394	2352	44
45	2974	2927	2880	2833	2787	2741	2696	2652	2607	2564	2520	2477	2435	2393	2351	45
46	2974	2926	2879	2832	2786	2741	2696	2651	2607	2563	2520	2477	2434	2392	2351	46
47	2973	2925	2878	2832	2785	2740	2695	2650	2606	2562	2519	2476	2434	2391	2350	47
48	2972	2924	2877	2831	2785	2739	2694	2649	2605	2561	2518	2475	2433	2391	2349	48
49	2971	2924	2877	2830	2784	2738	2693	2649	2604	2561	2517	2475	2432	2390	2348	49
50	2970	2923	2876	2829	2783	2738	2693	2648	2604	2560	2517	2474	2431	2389	2348	50
51	2970	2922	2875	2828	2782	2737	2692	2647	2603	2559	2516	2473	2431	2389	2347	51
52	2969	2921	2874	2828	2782	2736	2691	2646	2602	2559	2515	2472	2430	2388	2346	52
53	2968	2920	2874	2827	2781	2735	2690	2646	2602	2558	2515	2472	2429	2387	2346	53
54	2967	2920	2873	2826	2780	2735	2690	2645	2601	2557	2514	2471	2429	2387	2345	54
55	2966	2919	2872	2825	2779	2734	2689	2644	2600	2556	2513	2470	2428	2386	2344	55
56	2966	2918	2871	2825	2779	2733	2688	2643	2599	2556	2512	2470	2427	2385	2344	56
57	2965	2917	2870	2824	2778	2732	2688	2643	2599	2555	2512	2469	2427	2385	2343	57
58	2964	2916	2870	2823	2777	2732	2687	2642	2598	2554	2511	2468	2426	2384	2342	58
59	2963	2916	2869	2822	2776	2731	2686	2641	2597	2553	2510	2467	2425	2383	2342	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	1 Degree, or 1 Hour.															
″	45′	46′	47′	48′	49′	50′	51′	52′	53′	54′	55′	56′	57′	58′	59′	″
0	2341	2300	2259	2218	2178	2139	2099	2061	2022	1984	1946	1908	1871	1834	1797	0
1	2340	2299	2258	2218	2178	2138	2099	2060	2021	1983	1945	1908	1870	1833	1797	1
2	2340	2298	2258	2217	2177	2138	2098	2059	2021	1982	1945	1907	1870	1833	1796	2
3	2339	2298	2257	2217	2177	2137	2098	2059	2020	1982	1944	1906	1869	1832	1795	3
4	2338	2297	2256	2216	2176	2136	2097	2058	2019	1981	1943	1906	1868	1832	1795	4
5	2337	2296	2256	2215	2175	2136	2096	2057	2019	1981	1943	1905	1868	1831	1794	5
6	2337	2296	2255	2215	2175	2135	2096	2057	2018	1980	1942	1904	1867	1830	1794	6
7	2336	2295	2254	2214	2174	2134	2095	2056	2018	1979	1941	1904	1867	1830	1793	7
8	2335	2294	2254	2213	2173	2134	2094	2055	2017	1979	1941	1903	1866	1829	1792	8
9	2335	2294	2253	2213	2173	2133	2094	2055	2016	1978	1940	1903	1865	1828	1792	9
10	2334	2293	2252	2212	2172	2132	2093	2054	2016	1977	1940	1902	1865	1828	1791	10
11	2333	2292	2252	2211	2171	2132	2092	2053	2015	1977	1939	1901	1864	1827	1791	11
12	2333	2292	2251	2211	2171	2131	2092	2053	2014	1976	1938	1901	1863	1827	1790	12
13	2332	2291	2250	2210	2170	2130	2091	2052	2014	1975	1938	1900	1863	1826	1789	13
14	2331	2290	2249	2209	2169	2130	2090	2052	2013	1975	1937	1899	1862	1825	1789	14
15	2331	2289	2249	2208	2169	2129	2090	2051	2012	1974	1936	1899	1862	1825	1788	15
16	2330	2289	2248	2208	2168	2128	2089	2050	2012	1974	1936	1898	1861	1824	1788	16
17	2329	2288	2247	2207	2167	2128	2088	2050	2011	1973	1935	1898	1860	1824	1787	17
18	2328	2287	2247	2206	2167	2127	2088	2049	2010	1972	1934	1897	1860	1823	1786	18
19	2328	2287	2246	2206	2166	2126	2087	2048	2010	1972	1934	1896	1859	1822	1786	19
20	2327	2286	2245	2205	2165	2126	2087	2048	2009	1971	1933	1896	1859	1822	1785	20
21	2326	2285	2245	2204	2165	2125	2086	2047	2009	1970	1933	1895	1858	1821	1785	21
22	2326	2285	2244	2204	2164	2124	2085	2046	2008	1970	1932	1894	1857	1820	1784	22
23	2325	2284	2243	2203	2163	2124	2085	2046	2007	1969	1931	1894	1857	1820	1783	23
24	2324	2283	2243	2202	2163	2123	2084	2045	2007	1969	1931	1893	1856	1819	1783	24
25	2324	2283	2242	2202	2162	2122	2083	2044	2006	1968	1930	1893	1855	1819	1782	25
26	2323	2282	2241	2201	2161	2122	2083	2044	2005	1967	1929	1892	1855	1818	1782	26
27	2322	2281	2241	2200	2161	2121	2082	2043	2005	1967	1929	1891	1854	1817	1781	27
28	2322	2281	2240	2200	2160	2120	2081	2043	2004	1966	1928	1891	1854	1817	1780	28
29	2321	2280	2239	2199	2159	2120	2081	2042	2003	1965	1928	1890	1853	1816	1780	29
30	2320	2279	2239	2198	2159	2119	2080	2041	2003	1965	1927	1890	1852	1816	1779	30
31	2320	2279	2238	2198	2158	2118	2079	2041	2002	1964	1926	1889	1852	1815	1778	31
32	2319	2278	2237	2197	2157	2118	2079	2040	2002	1963	1926	1888	1851	1814	1778	32
33	2318	2277	2237	2196	2157	2117	2078	2039	2001	1963	1925	1888	1851	1814	1777	33
34	2318	2277	2236	2196	2156	2117	2077	2039	2000	1962	1924	1887	1850	1813	1777	34
35	2317	2276	2235	2195	2155	2116	2077	2038	2000	1962	1924	1886	1849	1813	1776	35
36	2316	2275	2235	2194	2155	2115	2076	2037	1999	1961	1923	1886	1849	1812	1775	36
37	2315	2275	2234	2194	2154	2115	2075	2037	1998	1960	1923	1885	1848	1811	1775	37
38	2315	2274	2233	2193	2153	2114	2075	2036	1998	1960	1922	1885	1847	1811	1774	38
39	2314	2273	2233	2192	2153	2113	2074	2035	1997	1959	1921	1884	1847	1810	1774	39
40	2313	2272	2232	2192	2152	2113	2074	2035	1996	1958	1921	1883	1846	1809	1773	40
41	2313	2272	2231	2191	2151	2112	2073	2034	1996	1958	1920	1883	1846	1809	1772	41
42	2312	2271	2231	2190	2151	2111	2072	2034	1995	1957	1919	1882	1845	1808	1772	42
43	2311	2270	2230	2190	2150	2111	2072	2033	1995	1957	1919	1881	1844	1808	1771	43
44	2311	2270	2229	2189	2149	2110	2071	2032	1994	1956	1918	1881	1844	1807	1771	44
45	2310	2269	2229	2188	2149	2109	2070	2032	1993	1955	1918	1880	1843	1806	1770	45
46	2309	2268	2228	2188	2148	2109	2070	2031	1993	1955	1917	1880	1843	1806	1769	46
47	2309	2268	2227	2187	2147	2108	2069	2030	1992	1954	1916	1879	1842	1805	1769	47
48	2308	2267	2227	2186	2147	2107	2068	2030	1991	1953	1916	1878	1841	1805	1768	48
49	2307	2266	2226	2186	2146	2107	2068	2029	1991	1953	1915	1878	1841	1804	1768	49
50	2307	2266	2225	2185	2145	2106	2067	2028	1990	1952	1914	1877	1840	1803	1767	50
51	2306	2265	2225	2184	2145	2105	2066	2028	1989	1951	1914	1876	1839	1803	1766	51
52	2305	2264	2224	2184	2144	2105	2066	2027	1989	1951	1913	1876	1839	1802	1766	52
53	2304	2264	2223	2183	2143	2104	2065	2026	1988	1950	1913	1875	1838	1802	1765	53
54	2304	2263	2223	2182	2143	2103	2064	2026	1988	1950	1912	1875	1838	1801	1765	54
55	2303	2262	2222	2182	2142	2103	2064	2025	1987	1949	1911	1874	1837	1800	1764	55
56	2302	2262	2221	2181	2141	2102	2063	2025	1986	1948	1911	1873	1836	1800	1763	56
57	2302	2261	2221	2181	2141	2102	2063	2024	1986	1948	1910	1873	1836	1799	1763	57
58	2301	2260	2220	2180	2140	2101	2062	2023	1985	1947	1909	1872	1835	1799	1762	58
59	2300	2260	2219	2179	2140	2100	2061	2023	1984	1946	1909	1872	1835	1798	1762	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	2 Degrees, or 2 Hours.															
″	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	12′	13′	14′	″
0	1761	1725	1689	1654	1619	1584	1549	1515	1481	1447	1413	1380	1347	1314	1282	0
1	1760	1724	1689	1653	1618	1583	1548	1514	1480	1446	1413	1380	1346	1314	1281	1
2	1760	1724	1688	1653	1617	1583	1548	1514	1480	1446	1412	1379	1346	1313	1281	2
3	1759	1723	1687	1652	1617	1582	1547	1513	1479	1445	1412	1378	1345	1313	1280	3
4	1759	1723	1687	1651	1616	1581	1547	1512	1478	1445	1411	1378	1345	1312	1280	4
5	1758	1722	1686	1651	1616	1581	1546	1512	1478	1444	1411	1377	1344	1312	1279	5
6	1757	1721	1686	1650	1615	1580	1546	1511	1477	1444	1410	1377	1344	1311	1278	6
7	1757	1721	1685	1650	1614	1580	1545	1511	1477	1443	1409	1376	1343	1310	1278	7
8	1756	1720	1684	1649	1614	1579	1544	1510	1476	1442	1409	1376	1343	1310	1277	8
9	1756	1720	1684	1648	1613	1578	1544	1510	1476	1442	1408	1375	1342	1309	1277	9
10	1755	1719	1683	1648	1613	1578	1543	1509	1475	1441	1408	1375	1342	1309	1276	10
11	1754	1718	1683	1647	1612	1577	1543	1508	1474	1441	1407	1374	1341	1308	1276	11
12	1754	1718	1682	1647	1612	1577	1542	1508	1474	1440	1407	1373	1340	1308	1275	12
13	1753	1717	1681	1646	1611	1576	1542	1507	1473	1440	1406	1373	1340	1307	1275	13
14	1753	1717	1681	1645	1610	1576	1541	1507	1473	1439	1406	1372	1339	1307	1274	14
15	1752	1716	1680	1645	1610	1575	1540	1506	1472	1438	1405	1372	1339	1306	1274	15
16	1751	1715	1680	1644	1609	1574	1540	1506	1472	1438	1404	1371	1338	1306	1273	16
17	1751	1715	1679	1644	1609	1574	1539	1505	1471	1437	1404	1371	1338	1305	1273	17
18	1750	1714	1679	1643	1608	1573	1539	1504	1471	1437	1403	1370	1337	1304	1272	18
19	1750	1714	1678	1643	1607	1573	1538	1504	1470	1436	1403	1370	1337	1304	1271	19
20	1749	1713	1677	1642	1607	1572	1538	1503	1469	1436	1402	1369	1336	1303	1271	20
21	1748	1712	1677	1641	1606	1572	1537	1503	1469	1435	1402	1368	1336	1303	1270	21
22	1748	1712	1676	1641	1606	1571	1536	1502	1468	1435	1401	1368	1335	1302	1270	22
23	1747	1711	1676	1640	1605	1570	1536	1502	1468	1434	1401	1367	1334	1302	1269	23
24	1747	1711	1675	1640	1605	1570	1535	1501	1467	1433	1400	1367	1334	1301	1269	24
25	1746	1710	1674	1639	1604	1569	1535	1501	1467	1433	1399	1366	1333	1301	1268	25
26	1745	1709	1674	1638	1603	1569	1534	1500	1466	1432	1399	1366	1333	1300	1268	26
27	1745	1709	1673	1638	1603	1568	1534	1499	1465	1432	1398	1365	1332	1300	1267	27
28	1744	1708	1673	1637	1602	1567	1533	1499	1465	1431	1398	1365	1332	1299	1267	28
29	1744	1708	1672	1637	1602	1567	1532	1498	1464	1431	1397	1364	1331	1299	1266	29
30	1743	1707	1671	1636	1601	1566	1532	1498	1464	1430	1397	1364	1331	1298	1266	30
31	1742	1706	1671	1636	1601	1566	1531	1497	1463	1430	1396	1363	1330	1297	1265	31
32	1742	1706	1670	1635	1600	1565	1531	1497	1463	1429	1396	1362	1330	1297	1264	32
33	1741	1705	1670	1634	1599	1565	1530	1496	1462	1428	1395	1362	1329	1296	1264	33
34	1741	1705	1669	1634	1599	1564	1530	1495	1461	1428	1394	1361	1328	1296	1263	34
35	1740	1704	1668	1633	1598	1563	1529	1495	1461	1427	1394	1361	1328	1295	1263	35
36	1739	1703	1668	1633	1598	1563	1528	1494	1460	1427	1393	1360	1327	1295	1262	36
37	1739	1703	1667	1632	1597	1562	1528	1494	1460	1426	1393	1360	1327	1294	1262	37
38	1738	1702	1667	1631	1596	1562	1527	1493	1459	1426	1392	1359	1326	1294	1261	38
39	1738	1702	1666	1631	1596	1561	1527	1493	1459	1425	1392	1359	1326	1293	1261	39
40	1737	1701	1666	1630	1595	1561	1526	1492	1458	1424	1391	1358	1325	1293	1260	40
41	1736	1700	1665	1630	1595	1560	1526	1491	1458	1424	1391	1357	1325	1292	1260	41
42	1736	1700	1664	1629	1594	1559	1525	1491	1457	1423	1390	1357	1324	1291	1259	42
43	1735	1699	1664	1628	1594	1559	1524	1490	1456	1423	1389	1356	1324	1291	1259	43
44	1735	1699	1663	1628	1593	1558	1524	1490	1456	1422	1389	1356	1323	1290	1258	44
45	1734	1698	1663	1627	1592	1558	1523	1489	1455	1422	1388	1355	1322	1290	1257	45
46	1733	1697	1662	1627	1592	1557	1523	1489	1455	1421	1388	1355	1322	1289	1257	46
47	1733	1697	1661	1626	1591	1557	1522	1488	1454	1421	1387	1354	1321	1289	1256	47
48	1732	1696	1661	1626	1591	1556	1522	1487	1454	1420	1387	1354	1321	1288	1256	48
49	1732	1696	1660	1625	1590	1555	1521	1487	1453	1419	1386	1353	1320	1288	1255	49
50	1731	1695	1660	1624	1589	1555	1520	1486	1452	1419	1386	1353	1320	1287	1255	50
51	1730	1695	1659	1624	1589	1554	1520	1486	1452	1418	1385	1352	1319	1287	1254	51
52	1730	1694	1658	1623	1588	1554	1519	1485	1451	1418	1384	1351	1319	1286	1254	52
53	1729	1693	1658	1623	1588	1553	1519	1485	1451	1417	1384	1351	1318	1286	1253	53
54	1729	1693	1657	1622	1587	1553	1518	1484	1450	1417	1383	1350	1318	1285	1253	54
55	1728	1692	1657	1621	1587	1552	1518	1484	1450	1416	1383	1350	1317	1284	1252	55
56	1727	1692	1656	1621	1586	1551	1517	1483	1449	1416	1382	1349	1316	1284	1252	56
57	1727	1691	1655	1620	1585	1551	1516	1482	1449	1415	1382	1349	1316	1283	1251	57
58	1726	1690	1655	1620	1585	1550	1516	1482	1448	1414	1381	1348	1315	1283	1251	58
59	1726	1690	1654	1619	1584	1550	1515	1481	1447	1414	1381	1348	1315	1282	1250	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	2 Degrees, or 2 Hours.															
″	15′	16′	17′	18′	19′	20′	21′	22′	23′	24′	25′	26′	27′	28′	29′	″
0	1249	1217	1186	1154	1123	1091	1061	1030	0999	0969	0939	0909	0880	0850	0821	0
1	1249	1217	1185	1153	1122	1091	1060	1029	0999	0969	0939	0909	0879	0850	0820	1
2	1248	1216	1185	1153	1122	1090	1060	1029	0998	0968	0938	0908	0879	0849	0820	2
3	1248	1216	1184	1152	1121	1090	1059	1028	0998	0968	0938	0908	0878	0849	0819	3
4	1247	1215	1183	1152	1121	1089	1059	1028	0997	0967	0937	0907	0878	0848	0819	4
5	1247	1215	1183	1151	1120	1089	1058	1027	0997	0967	0937	0907	0877	0848	0818	5
6	1246	1214	1182	1151	1120	1088	1058	1027	0996	0966	0936	0906	0877	0847	0818	6
7	1246	1214	1182	1150	1119	1088	1057	1026	0996	0966	0936	0906	0876	0847	0818	7
8	1245	1213	1181	1150	1118	1087	1056	1026	0995	0965	0935	0905	0876	0846	0817	8
9	1245	1213	1181	1149	1118	1087	1056	1025	0995	0965	0935	0905	0875	0846	0817	9
10	1244	1212	1180	1149	1117	1086	1055	1025	0994	0964	0934	0904	0875	0845	0816	10
11	1244	1212	1180	1148	1117	1086	1055	1024	0994	0964	0934	0904	0874	0845	0816	11
12	1243	1211	1179	1148	1116	1085	1054	1024	0993	0963	0933	0903	0874	0844	0815	12
13	1242	1210	1179	1147	1116	1085	1054	1023	0993	0963	0933	0903	0873	0844	0815	13
14	1242	1210	1178	1147	1115	1084	1053	1023	0992	0962	0932	0902	0873	0843	0814	14
15	1241	1209	1178	1146	1115	1084	1053	1022	0992	0962	0932	0902	0872	0843	0814	15
16	1241	1209	1177	1146	1114	1083	1052	1022	0991	0961	0931	0901	0872	0842	0813	16
17	1240	1208	1177	1145	1114	1083	1052	1021	0991	0961	0931	0901	0871	0842	0813	17
18	1240	1208	1176	1145	1113	1082	1051	1021	0990	0960	0930	0900	0871	0841	0812	18
19	1239	1207	1176	1144	1113	1082	1051	1020	0990	0960	0930	0900	0870	0841	0812	19
20	1239	1207	1175	1144	1112	1081	1050	1020	0989	0959	0929	0899	0870	0840	0811	20
21	1238	1206	1174	1143	1112	1081	1050	1019	0989	0959	0929	0899	0869	0840	0811	21
22	1238	1206	1174	1142	1111	1080	1049	1019	0988	0958	0928	0898	0869	0839	0810	22
23	1237	1205	1173	1142	1111	1080	1049	1018	0988	0958	0928	0898	0868	0839	0810	23
24	1237	1205	1173	1141	1110	1079	1048	1018	0987	0957	0927	0897	0868	0838	0809	24
25	1236	1204	1172	1141	1110	1079	1048	1017	0987	0957	0927	0897	0867	0838	0809	25
26	1236	1204	1172	1140	1109	1078	1047	1017	0986	0956	0926	0896	0867	0837	0808	26
27	1235	1203	1171	1140	1109	1078	1047	1016	0986	0956	0926	0896	0866	0837	0808	27
28	1234	1203	1171	1139	1108	1077	1046	1016	0985	0955	0925	0895	0866	0836	0807	28
29	1234	1202	1170	1139	1108	1077	1046	1015	0985	0955	0925	0895	0865	0836	0807	29
30	1233	1201	1170	1138	1107	1076	1045	1015	0984	0954	0924	0894	0865	0836	0806	30
31	1233	1201	1169	1138	1107	1075	1045	1014	0984	0954	0924	0894	0864	0835	0806	31
32	1232	1200	1169	1137	1106	1075	1044	1014	0983	0953	0923	0893	0864	0835	0805	32
33	1232	1200	1168	1137	1105	1074	1044	1013	0983	0953	0923	0893	0863	0834	0805	33
34	1231	1199	1168	1136	1105	1074	1043	1013	0982	0952	0922	0892	0863	0834	0804	34
35	1231	1199	1167	1136	1104	1073	1043	1012	0982	0952	0922	0892	0862	0833	0804	35
36	1230	1198	1167	1135	1104	1073	1042	1012	0981	0951	0921	0891	0862	0833	0803	36
37	1230	1198	1166	1135	1103	1072	1042	1011	0981	0951	0921	0891	0861	0832	0803	37
38	1229	1197	1166	1134	1103	1072	1041	1011	0980	0950	0920	0890	0861	0832	0802	38
39	1229	1197	1165	1134	1102	1071	1041	1010	0980	0950	0920	0890	0860	0831	0802	39
40	1228	1196	1164	1133	1102	1071	1040	1010	0979	0949	0919	0889	0860	0831	0802	40
41	1228	1196	1164	1133	1101	1070	1040	1009	0979	0949	0919	0889	0859	0830	0801	41
42	1227	1195	1163	1132	1101	1070	1039	1009	0978	0948	0918	0888	0859	0830	0801	42
43	1226	1195	1163	1131	1100	1069	1039	1008	0978	0948	0918	0888	0858	0829	0800	43
44	1226	1194	1162	1131	1100	1069	1038	1008	0977	0947	0917	0887	0858	0829	0800	44
45	1225	1194	1162	1130	1099	1068	1038	1007	0977	0947	0917	0887	0858	0828	0799	45
46	1225	1193	1161	1130	1099	1068	1037	1007	0976	0946	0916	0887	0857	0828	0799	46
47	1224	1192	1161	1129	1098	1067	1037	1006	0976	0946	0916	0886	0857	0827	0798	47
48	1224	1192	1160	1129	1098	1067	1036	1005	0975	0945	0915	0886	0856	0827	0798	48
49	1223	1191	1160	1128	1097	1066	1036	1005	0975	0945	0915	0885	0856	0826	0797	49
50	1223	1191	1159	1128	1097	1066	1035	1004	0974	0944	0914	0885	0855	0826	0797	50
51	1222	1190	1159	1127	1096	1065	1034	1004	0974	0944	0914	0884	0855	0825	0796	51
52	1222	1190	1158	1127	1096	1065	1034	1003	0973	0943	0913	0884	0854	0825	0796	52
53	1221	1189	1158	1126	1095	1064	1033	1003	0973	0943	0913	0883	0854	0824	0795	53
54	1221	1189	1157	1126	1095	1064	1033	1002	0972	0942	0912	0883	0853	0824	0795	54
55	1220	1188	1157	1125	1094	1063	1032	1002	0972	0942	0912	0882	0853	0823	0794	55
56	1220	1188	1156	1125	1094	1063	1032	1001	0971	0941	0911	0882	0852	0823	0794	56
57	1219	1187	1156	1124	1093	1062	1031	1001	0971	0941	0911	0881	0852	0822	0793	57
58	1218	1187	1155	1124	1093	1062	1031	1000	0970	0940	0910	0881	0851	0822	0793	58
59	1218	1186	1155	1123	1092	1061	1030	1000	0970	0940	0910	0880	0851	0821	0792	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

	2 Degrees, or 2 Hours.															
″	30′	31′	32′	33′	34′	35′	36′	37′	38′	39′	40′	41′	42′	43′	44′	″
0	0792	0763	0734	0706	0678	0649	0621	0594	0566	0539	0512	0484	0458	0431	0404	0
1	0791	0763	0734	0705	0677	0649	0621	0593	0566	0538	0511	0484	0457	0430	0404	1
2	0791	0762	0733	0705	0677	0649	0621	0593	0565	0538	0511	0484	0457	0430	0403	2
3	0790	0762	0733	0704	0676	0648	0620	0592	0565	0537	0510	0483	0456	0430	0403	3
4	0790	0761	0732	0704	0676	0648	0620	0592	0564	0537	0510	0483	0456	0429	0403	4
5	0789	0761	0732	0703	0675	0647	0619	0591	0564	0537	0509	0482	0455	0429	0402	5
6	0789	0760	0731	0703	0675	0647	0619	0591	0563	0536	0509	0482	0455	0428	0402	6
7	0788	0760	0731	0703	0674	0646	0618	0591	0563	0536	0508	0481	0454	0428	0401	7
8	0788	0759	0731	0702	0674	0646	0618	0590	0563	0535	0508	0481	0454	0427	0401	8
9	0788	0759	0730	0702	0673	0645	0617	0590	0562	0535	0508	0480	0454	0427	0400	9
10	0787	0758	0730	0701	0673	0645	0617	0589	0562	0534	0507	0480	0453	0426	0400	10
11	0787	0758	0729	0701	0672	0644	0616	0589	0561	0534	0507	0480	0453	0426	0399	11
12	0786	0757	0729	0700	0672	0644	0616	0588	0561	0533	0506	0479	0452	0426	0399	12
13	0786	0757	0728	0700	0671	0643	0616	0588	0560	0533	0506	0479	0452	0425	0399	13
14	0785	0756	0728	0699	0671	0643	0615	0587	0560	0532	0505	0478	0451	0425	0398	14
15	0785	0756	0727	0699	0671	0642	0615	0587	0559	0532	0505	0478	0451	0424	0398	15
16	0784	0755	0727	0698	0670	0642	0614	0586	0559	0532	0504	0477	0450	0424	0397	16
17	0784	0755	0726	0698	0670	0642	0614	0586	0558	0531	0504	0477	0450	0423	0397	17
18	0783	0754	0726	0697	0669	0641	0613	0585	0558	0531	0503	0476	0450	0423	0396	18
19	0783	0754	0725	0697	0669	0641	0613	0585	0558	0530	0503	0476	0449	0422	0396	19
20	0782	0753	0725	0696	0668	0640	0612	0585	0557	0530	0503	0476	0449	0422	0396	20
21	0782	0753	0724	0696	0668	0640	0612	0584	0557	0529	0502	0475	0448	0422	0395	21
22	0781	0752	0724	0695	0667	0639	0611	0584	0556	0529	0502	0475	0448	0421	0395	22
23	0781	0752	0723	0695	0667	0639	0611	0583	0556	0528	0501	0474	0447	0421	0394	23
24	0780	0752	0723	0695	0666	0638	0610	0583	0555	0528	0501	0474	0447	0420	0394	24
25	0780	0751	0722	0694	0666	0638	0610	0582	0555	0527	0500	0473	0446	0420	0393	25
26	0779	0751	0722	0694	0665	0637	0609	0582	0554	0527	0500	0473	0446	0419	0393	26
27	0779	0750	0722	0693	0665	0637	0609	0581	0554	0527	0499	0472	0446	0419	0392	27
28	0778	0750	0721	0693	0664	0636	0609	0581	0553	0526	0499	0472	0445	0418	0392	28
29	0778	0749	0721	0692	0664	0636	0608	0580	0553	0526	0498	0471	0445	0418	0392	29
30	0777	0749	0720	0692	0663	0635	0608	0580	0552	0525	0498	0471	0444	0418	0391	30
31	0777	0748	0720	0691	0663	0635	0607	0580	0552	0525	0498	0471	0444	0417	0391	31
32	0776	0748	0719	0691	0663	0635	0607	0579	0552	0524	0497	0470	0443	0417	0390	32
33	0776	0747	0719	0690	0662	0634	0606	0579	0551	0524	0497	0470	0443	0416	0390	33
34	0775	0747	0718	0690	0662	0634	0606	0578	0551	0523	0496	0469	0442	0416	0389	34
35	0775	0746	0718	0689	0661	0633	0605	0578	0550	0523	0496	0469	0442	0415	0389	35
36	0775	0746	0717	0689	0661	0633	0605	0577	0550	0522	0495	0468	0442	0415	0388	36
37	0774	0745	0717	0688	0660	0632	0604	0577	0549	0522	0495	0468	0441	0414	0388	37
38	0774	0745	0716	0688	0660	0632	0604	0576	0549	0522	0494	0467	0441	0414	0388	38
39	0773	0744	0716	0687	0659	0631	0603	0576	0548	0521	0494	0467	0440	0414	0387	39
40	0773	0744	0715	0687	0659	0631	0603	0575	0548	0521	0494	0467	0440	0413	0387	40
41	0772	0743	0715	0687	0658	0630	0603	0575	0547	0520	0493	0466	0439	0413	0386	41
42	0772	0743	0714	0686	0658	0630	0602	0574	0547	0520	0493	0466	0439	0412	0386	42
43	0771	0742	0714	0686	0657	0629	0602	0574	0547	0519	0492	0465	0438	0412	0385	43
44	0771	0742	0713	0685	0657	0629	0601	0574	0546	0519	0492	0465	0438	0411	0385	44
45	0770	0741	0713	0685	0656	0628	0601	0573	0546	0518	0491	0464	0438	0411	0385	45
46	0770	0741	0712	0684	0656	0628	0600	0573	0545	0518	0491	0464	0437	0411	0384	46
47	0769	0741	0712	0684	0656	0628	0600	0572	0545	0517	0490	0463	0437	0410	0384	47
48	0769	0740	0712	0683	0655	0627	0599	0572	0544	0517	0490	0463	0436	0410	0383	48
49	0768	0740	0711	0683	0655	0627	0599	0571	0544	0517	0489	0463	0436	0409	0383	49
50	0768	0739	0711	0682	0654	0626	0598	0571	0543	0516	0489	0462	0435	0409	0382	50
51	0767	0739	0710	0682	0654	0626	0598	0570	0543	0516	0489	0462	0435	0408	0382	51
52	0767	0738	0710	0681	0653	0625	0597	0570	0542	0515	0488	0461	0434	0408	0381	52
53	0766	0738	0709	0681	0653	0625	0597	0569	0542	0515	0488	0461	0434	0407	0381	53
54	0766	0737	0709	0680	0652	0624	0597	0569	0542	0514	0487	0460	0434	0407	0381	54
55	0765	0737	0708	0680	0652	0624	0596	0568	0541	0514	0487	0460	0433	0407	0380	55
56	0765	0736	0708	0679	0651	0623	0596	0568	0541	0513	0486	0459	0433	0406	0380	56
57	0764	0736	0707	0679	0651	0623	0595	0568	0540	0513	0486	0459	0432	0406	0379	57
58	0764	0735	0707	0678	0650	0622	0595	0567	0540	0512	0485	0459	0432	0405	0379	58
59	0763	0735	0706	0678	0650	0622	0594	0567	0539	0512	0485	0458	0431	0405	0378	59

TABLE X.

Proportional Logarithms for 3 Degrees, or 3 Hours.

2 Degrees, or 2 Hours.

″	45′	46′	47′	48′	49′	50′	51′	52′	53′	54′	55′	56′	57′	58′	59′	″
0	0378	0352	0326	0300	0274	0248	0223	0197	0172	0147	0122	0098	0073	0049	0024	0
1	0377	0351	0325	0299	0273	0248	0222	0197	0172	0147	0122	0097	0073	0048	0024	1
2	0377	0351	0325	0299	0273	0247	0222	0197	0171	0146	0122	0097	0072	0048	0023	2
3	0377	0350	0324	0298	0273	0247	0222	0196	0171	0146	0121	0096	0072	0047	0023	3
4	0376	0350	0324	0298	0272	0247	0221	0196	0171	0146	0121	0096	0071	0047	0023	4
5	0376	0350	0323	0298	0272	0246	0221	0195	0170	0145	0120	0096	0071	0047	0022	5
6	0375	0349	0323	0297	0271	0246	0220	0195	0170	0145	0120	0095	0071	0046	0022	6
7	0375	0349	0323	0297	0271	0245	0220	0195	0169	0144	0120	0095	0070	0046	0021	7
8	0374	0348	0322	0296	0270	0245	0219	0194	0169	0144	0119	0094	0070	0045	0021	8
9	0374	0348	0322	0296	0270	0244	0219	0194	0169	0144	0119	0094	0069	0045	0021	9
10	0374	0347	0321	0295	0270	0244	0219	0193	0168	0143	0118	0094	0069	0045	0020	10
11	0373	0347	0321	0295	0269	0244	0218	0193	0168	0143	0118	0093	0069	0044	0020	11
12	0373	0346	0320	0295	0269	0243	0218	0192	0167	0142	0117	0093	0068	0044	0019	12
13	0372	0346	0320	0294	0268	0243	0217	0192	0167	0142	0117	0092	0068	0043	0019	13
14	0372	0346	0320	0294	0268	0242	0217	0192	0166	0141	0117	0092	0067	0043	0019	14
15	0371	0345	0319	0293	0267	0242	0216	0191	0166	0141	0116	0091	0067	0042	0018	15
16	0371	0345	0319	0293	0267	0241	0216	0191	0166	0141	0116	0091	0067	0042	0018	16
17	0370	0344	0318	0292	0267	0241	0216	0190	0165	0140	0115	0091	0066	0042	0017	17
18	0370	0344	0318	0292	0266	0241	0215	0190	0165	0140	0115	0090	0066	0041	0017	18
19	0370	0343	0317	0292	0266	0240	0215	0190	0164	0139	0115	0090	0065	0041	0017	19
20	0369	0343	0317	0291	0265	0240	0214	0189	0164	0139	0114	0089	0065	0040	0016	20
21	0369	0343	0317	0291	0265	0239	0214	0189	0164	0139	0114	0089	0064	0040	0016	21
22	0368	0342	0316	0290	0264	0239	0214	0188	0163	0138	0113	0089	0064	0040	0015	22
23	0368	0342	0316	0290	0264	0239	0213	0188	0163	0138	0113	0088	0064	0039	0015	23
24	0367	0341	0315	0289	0264	0238	0213	0187	0162	0137	0112	0088	0063	0039	0015	24
25	0367	0341	0315	0289	0263	0238	0212	0187	0162	0137	0112	0087	0063	0038	0014	25
26	0367	0340	0314	0288	0263	0237	0212	0187	0161	0136	0112	0087	0062	0038	0014	26
27	0366	0340	0314	0288	0262	0237	0211	0186	0161	0136	0111	0087	0062	0038	0013	27
28	0366	0340	0313	0288	0262	0236	0211	0186	0161	0136	0111	0086	0062	0037	0013	28
29	0365	0339	0313	0287	0262	0236	0211	0185	0160	0135	0110	0086	0061	0037	0013	29
30	0365	0339	0313	0287	0261	0236	0210	0185	0160	0135	0110	0085	0061	0036	0012	30
31	0364	0338	0312	0286	0261	0235	0210	0184	0159	0134	0110	0085	0060	0036	0012	31
32	0364	0338	0312	0286	0260	0235	0209	0184	0159	0134	0109	0085	0060	0036	0011	32
33	0363	0337	0311	0285	0260	0234	0209	0184	0159	0134	0109	0084	0060	0035	0011	33
34	0363	0337	0311	0285	0259	0234	0208	0183	0158	0133	0108	0084	0059	0035	0011	34
35	0363	0336	0310	0285	0259	0233	0208	0183	0158	0133	0108	0083	0059	0034	0010	35
36	0362	0336	0310	0284	0259	0233	0208	0182	0157	0132	0108	0083	0058	0034	0010	36
37	0362	0336	0310	0284	0258	0233	0207	0182	0157	0132	0107	0082	0058	0034	0009	37
38	0361	0335	0309	0283	0258	0232	0207	0182	0156	0132	0107	0082	0058	0033	0009	38
39	0361	0335	0309	0283	0257	0232	0206	0181	0156	0131	0106	0082	0057	0033	0009	39
40	0360	0334	0308	0282	0257	0231	0206	0181	0156	0131	0106	0081	0057	0032	0008	40
41	0360	0334	0308	0282	0256	0231	0205	0180	0155	0130	0105	0081	0056	0032	0008	41
42	0360	0333	0307	0282	0256	0230	0205	0180	0155	0130	0105	0080	0056	0032	0007	42
43	0359	0333	0307	0281	0256	0230	0205	0179	0154	0129	0105	0080	0055	0031	0007	43
44	0359	0333	0307	0281	0255	0230	0204	0179	0154	0129	0104	0080	0055	0031	0006	44
45	0358	0332	0306	0280	0255	0229	0204	0179	0154	0129	0104	0079	0055	0030	0006	45
46	0358	0332	0306	0280	0254	0229	0203	0178	0153	0128	0103	0079	0054	0030	0006	46
47	0357	0331	0305	0279	0254	0228	0203	0178	0153	0128	0103	0078	0054	0030	0005	47
48	0357	0331	0305	0279	0253	0228	0203	0177	0152	0127	0103	0078	0053	0029	0005	48
49	0356	0330	0304	0279	0253	0227	0202	0177	0152	0127	0102	0078	0053	0029	0004	49
50	0356	0330	0304	0278	0253	0227	0202	0176	0151	0127	0102	0077	0053	0028	0004	50
51	0356	0330	0304	0278	0252	0227	0201	0176	0151	0126	0101	0077	0052	0028	0004	51
52	0355	0329	0303	0277	0252	0226	0201	0176	0151	0126	0101	0076	0052	0027	0003	52
53	0355	0329	0303	0277	0251	0226	0200	0175	0150	0125	0101	0076	0051	0027	0003	53
54	0354	0328	0302	0276	0251	0225	0200	0175	0150	0125	0100	0075	0051	0027	0002	54
55	0354	0328	0302	0276	0250	0225	0200	0174	0149	0124	0100	0075	0051	0026	0002	55
56	0353	0327	0301	0276	0250	0225	0199	0174	0149	0124	0099	0075	0050	0026	0002	56
57	0353	0327	0301	0275	0250	0224	0199	0174	0149	0124	0099	0074	0050	0025	0001	57
58	0353	0326	0301	0275	0249	0224	0198	0173	0148	0123	0098	0074	0049	0025	0001	58
59	0352	0326	0300	0274	0249	0223	0198	0173	0148	0123	0098	0073	0049	0025	0000	59

TIME TABLES.

TABLE XI.—To convert Space into Time.

°	H. ′	°	H. ′	°	H. ′	°	H. ′	°	H. ′	°	H. ′	°	H. ′	°	H. ′	°	H. ′
′	′ ″	′	′ ″	′	′ ″	′	′ ″	′	′ ″	′	′ ″	′	′ ″	′	′ ″	′	′ ″
″	″ ‴	″	″ ‴	″	″ ‴	″	″ ‴	″	″ ‴	″	″ ‴	″	″ ‴	″	″ ‴	″	″ ‴
1	0 4	21	1 24	41	2 44	61	4 4	81	5 24	101	6 44	121	8 4	141	9 24	161	10 44
2	0 8	22	1 28	42	2 48	62	4 8	82	5 28	102	6 48	122	8 8	142	9 28	162	10 48
3	0 12	23	1 32	43	2 52	63	4 12	83	5 32	103	6 52	123	8 12	143	9 32	163	10 52
4	0 16	24	1 36	44	2 56	64	4 16	84	5 36	104	6 56	124	8 16	144	9 36	164	10 56
5	0 20	25	1 40	45	3 0	65	4 20	85	5 40	105	7 0	125	8 20	145	9 40	165	11 0
6	0 24	26	1 44	46	3 4	66	4 24	86	5 44	106	7 4	126	8 24	146	9 44	166	11 4
7	0 28	27	1 48	47	3 8	67	4 28	87	5 48	107	7 8	127	8 28	147	9 48	167	11 8
8	0 32	28	1 52	48	3 12	68	4 32	88	5 52	108	7 12	128	8 32	148	9 52	168	11 12
9	0 36	29	1 56	49	3 16	69	4 36	89	5 56	109	7 16	129	8 36	149	9 56	169	11 16
10	0 40	30	2 0	50	3 20	70	4 40	90	6 0	110	7 20	130	8 40	150	10 0	170	11 20
11	0 44	31	2 4	51	3 24	71	4 44	91	6 4	111	7 24	131	8 44	151	10 4	171	11 24
12	0 48	32	2 8	52	3 28	72	4 48	92	6 8	112	7 28	132	8 48	152	10 8	172	11 28
13	0 52	33	2 12	53	3 32	73	4 52	93	6 12	113	7 32	133	8 52	153	10 12	173	11 32
14	0 56	34	2 16	54	3 36	74	4 56	94	6 16	114	7 36	134	8 56	154	10 16	174	11 36
15	1 0	35	2 20	55	3 40	75	5 0	95	6 20	115	7 40	135	9 0	155	10 20	175	11 40
16	1 4	36	2 24	56	3 44	76	5 4	96	6 24	116	7 44	136	9 4	156	10 24	176	11 44
17	1 8	37	2 28	57	3 48	77	5 8	97	6 28	117	7 48	137	9 8	157	10 28	177	11 48
18	1 12	38	2 32	58	3 52	78	5 12	98	6 32	118	7 52	138	9 12	158	10 32	178	11 52
19	1 16	39	2 36	59	3 56	79	5 16	99	6 36	119	7 56	139	9 16	159	10 36	179	11 56
20	1 20	40	2 40	60	4 0	80	5 20	100	6 40	120	8 0	140	9 20	160	10 40	180	12 0

TABLE XII.—Correction of the ☉'s Right Ascension.

☉'s Rt. Ascen.	Hours of Greenwich Time.												Min. of Green. Time.				
	1 h.	2 h.	3 h.	4 h.	5 h.	6 h.	7 h.	8 h.	9 h.	10 h.	11 h.	12 h.	10′	20′	30′	40′	50′
0h 0	0′ 9″	0′ 18″	0′ 27″	0′ 36″	0′ 45″	0′ 54″	1′ 4″	1′ 13″	1′ 22″	1′ 31″	1′ 40″	1′ 49″	1″	3″	4″	6″	7″
1 0	0 9	0 18	0 27	0 36	0 46	0 55	1 4	1 13	1 22	1 31	1 40	1 49	1	3	4	6	8
2 0	0 9	0 19	0 28	0 37	0 47	0 56	1 5	1 15	1 24	1 33	1 43	1 52	2	3	5	6	8
2 30	0 10	0 19	0 28	0 38	0 47	0 57	1 6	1 16	1 25	1 35	1 45	1 54	2	3	5	6	8
3 0	0 10	0 19	0 29	0 39	0 48	0 58	1 8	1 17	1 27	1 37	1 46	1 56	2	3	5	6	8
3 30	0 10	0 19	0 29	0 39	0 49	0 59	1 9	1 18	1 28	1 38	1 48	1 58	2	3	5	6	8
4 0	0 10	0 20	0 30	0 40	0 50	1 0	1 10	1 20	1 30	1 40	1 50	2 1	2	3	5	7	8
4 30	0 10	0 20	0 30	0 40	0 50	1 1	1 11	1 21	1 31	1 41	1 51	2 2	2	3	5	7	8
5 0	0 10	0 21	0 31	0 41	0 51	1 2	1 12	1 22	1 33	1 43	1 53	2 4	2	3	5	7	8
6 0	0 10	0 21	0 31	0 42	0 52	1 2	1 13	1 23	1 34	1 44	1 54	2 5	2	3	5	7	9
7 0	0 10	0 21	0 31	0 41	0 51	1 2	1 12	1 22	1 32	1 43	1 53	2 3	2	3	5	7	8
7 30	0 10	0 21	0 31	0 41	0 51	1 1	1 11	1 21	1 31	1 41	1 51	2 1	2	3	5	7	8
8 0	0 10	0 20	0 30	0 40	0 50	1 0	1 10	1 20	1 30	1 40	1 50	2 0	2	3	5	7	8
8 30	0 10	0 20	0 30	0 39	0 49	0 59	1 8	1 18	1 28	1 38	1 48	1 58	2	3	5	7	8
9 0	0 10	0 19	0 29	0 38	0 48	0 58	1 7	1 17	1 26	1 36	1 46	1 55	2	3	5	6	8
9 30	0 10	0 19	0 29	0 38	0 47	0 57	1 6	1 16	1 25	1 34	1 44	1 53	2	3	5	6	8
10 0	0 9	0 18	0 28	0 37	0 46	0 55	1 5	1 14	1 23	1 32	1 42	1 51	1	3	4	6	8
10 30	0 9	0 18	0 28	0 37	0 46	0 54	1 4	1 13	1 22	1 31	1 41	1 50	1	3	4	6	8
11 0	0 9	0 18	0 27	0 36	0 45	0 54	1 3	1 12	1 21	1 30	1 39	1 48	1	3	4	6	8
12 0	0 9	0 18	0 27	0 36	0 45	0 54	1 3	1 12	1 21	1 30	1 39	1 48	1	3	4	6	7
13 0	0 9	0 18	0 28	0 37	0 46	0 55	1 4	1 13	1 23	1 32	1 41	1 50	1	3	4	6	7
13 30	0 9	0 18	0 28	0 37	0 47	0 56	1 5	1 15	1 24	1 34	1 43	1 52	2	3	5	6	7
14 0	0 10	0 19	0 29	0 38	0 48	0 58	1 7	1 17	1 26	1 36	1 46	1 55	2	3	5	6	8
14 30	0 10	0 19	0 29	0 39	0 49	0 59	1 9	1 19	1 28	1 38	1 48	1 58	2	3	5	6	8
15 0	0 10	0 20	0 30	0 40	0 50	1 1	1 11	1 21	1 31	1 41	1 51	2 1	2	3	5	7	8
15 30	0 10	0 20	0 31	0 41	0 51	1 2	1 12	1 23	1 33	1 43	1 54	2 4	2	3	5	7	8
16 0	0 11	0 21	0 32	0 42	0 53	1 4	1 14	1 25	1 35	1 46	1 57	2 7	2	4	5	7	9
16 30	0 11	0 21	0 32	0 43	0 54	1 5	1 15	1 26	1 37	1 48	1 59	2 9	2	4	5	7	9
17 0	0 11	0 22	0 33	0 44	0 55	1 6	1 17	1 28	1 39	1 50	2 1	2 12	2	4	5	7	9
18 0	0 11	0 22	0 33	0 44	0 56	1 7	1 18	1 29	1 40	1 51	2 2	2 13	2	4	5	7	9
19 0	0 11	0 22	0 33	0 44	0 55	1 6	1 17	1 28	1 39	1 50	2 1	2 12	2	4	5	7	9
19 30	0 11	0 22	0 32	0 43	0 54	1 5	1 16	1 27	1 37	1 48	1 59	2 10	2	4	5	7	9
20 0	0 11	0 21	0 32	0 43	0 53	1 4	1 14	1 25	1 36	1 46	1 57	2 8	2	4	5	7	9
20 30	0 11	0 21	0 31	0 42	0 52	1 3	1 13	1 23	1 34	1 44	1 55	2 5	2	4	5	7	9
21 0	0 10	0 20	0 30	0 41	0 51	1 1	1 11	1 21	1 31	1 42	1 52	2 2	2	3	5	7	8
21 30	0 10	0 20	0 30	0 40	0 49	0 59	1 9	1 19	1 29	1 40	1 49	1 59	2	3	5	7	8
22 0	0 10	0 19	0 29	0 39	0 48	0 58	1 8	1 17	1 27	1 37	1 46	1 56	2	3	5	6	8
22 30	0 10	0 19	0 29	0 38	0 48	0 57	1 7	1 16	1 25	1 35	1 44	1 54	2	3	5	6	8
23 0	0 9	0 19	0 28	0 37	0 47	0 56	1 6	1 15	1 24	1 34	1 43	1 52	2	3	5	6	8
23 30	0 9	0 19	0 28	0 37	0 46	0 55	1 5	1 14	1 23	1 33	1 42	1 51	1	3	4	6	8

TABLE XIII.

Correction of Sun's Declination.

Greenw. Time.	DECLINATION.																										
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	21½°	22°	22½°	23°	23½°	23¾°
1 h.	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	0′	0′	0′	0′	0′	0′	0′
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0
3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	0	0
4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	2	2	2	2	1	1	1	1	0
5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	2	2	2	1	1	1	0
6	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	4	4	4	4	3	3	2	2	2	1	1	1	0
7	7	7	7	7	7	7	7	6	6	6	6	6	6	6	5	5	5	5	4	4	3	3	3	2	1	1	0	
8	8	8	8	8	8	8	8	7	7	7	7	7	7	6	6	6	6	5	5	4	4	3	3	2	2	1	0	
9	9	9	9	9	9	9	8	8	8	8	8	8	7	7	7	7	6	6	5	5	4	4	3	3	2	1	0	
10	10	10	10	10	10	10	9	9	9	9	9	9	8	8	8	7	7	6	5	5	4	4	3	2	1	0		
11	11	11	11	11	11	11	10	10	10	10	10	9	9	9	9	8	8	8	7	7	6	5	5	4	3	2	0	
12	12	12	12	12	12	12	11	11	11	11	11	10	10	10	10	9	9	8	8	7	6	5	5	4	4	2	2	0

TABLE XIV.

Correction of the Equation of Time.

Greenw. Time	DAILY VARIATION.																										
	1″	2″	4″	6″	8″	10″	11″	12″	13″	14″	15″	16″	17″	18″	19″	20″	21″	22″	23″	24″	25″	26″	27″	28″	29″	30″	31″	32″
1 h.	0″	0″	0″	0″	0″	0″	0″	0″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	2″	2″
2	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3
3	0	0	0	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4
4	0	0	0	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5
5	0	0	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6	6	6	6
6	0	0	1	1	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8
7	0	1	1	2	2	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	9	9
8	0	1	1	2	3	3	4	4	4	4	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11
9	0	1	1	2	3	3	4	4	5	5	6	6	6	7	7	7	8	8	9	9	9	10	10	10	11	11	12	12
10	0	1	2	2	3	4	5	5	5	6	6	7	7	7	8	8	9	9	9	10	10	11	11	12	12	12	13	13
11	0	1	2	3	4	5	5	5	6	6	7	7	8	8	9	9	10	10	10	11	11	12	12	13	13	14	14	15
12	0	1	2	3	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16

TABLE XV.

Correction of a Star's Altitude.

Alt.	HEIGHT OF EYE IN FEET.												
	0	4	8	12	16	18	20	22	24	26	28	30	32
6°	8′	10′	11′	12′	12′	13′	13′	13′	13′	13′	14′	14′	14′
7	7	9	10	11	11	11	12	12	12	12	12	13	13
8	6	8	9	10	10	11	11	11	11	11	12	12	12
9	6	8	9	9	10	10	10	11	11	11	11	11	11
10	5	7	8	9	9	9	10	10	10	10	10	11	11
11	5	7	8	8	9	9	9	9	9	10	10	10	10
12	4	6	7	8	8	8	9	9	9	9	10	10	10
13	4	6	7	7	8	8	8	9	9	9	9	9	10
14	4	6	6	7	8	8	8	8	8	8	9	9	9
15	3	5	6	7	7	8	8	8	8	8	9	9	9
16	3	5	6	7	7	7	8	8	8	8	8	9	9
17	3	5	6	6	7	7	7	8	8	8	8	8	9
18	3	5	6	6	7	7	7	7	8	8	8	8	8
19	3	5	6	6	7	7	7	7	7	8	8	8	8
20	3	5	5	6	6	7	7	7	7	7	8	8	8
22	2	4	5	6	6	6	7	7	7	7	7	8	8
26	2	4	5	5	6	6	6	6	7	7	7	7	7
30	2	4	4	5	5	6	6	6	6	7	7	7	7
35	1	3	4	5	5	5	6	6	6	6	6	7	7
40	1	3	4	5	5	5	5	6	6	6	6	6	7
50	1	3	3	4	5	5	5	5	5	6	6	6	6
60	1	3	3	4	4	5	5	5	5	5	6	6	6
70	0	2	3	4	4	4	5	5	5	5	5	6	6
80	0	2	3	4	4	4	4	5	5	5	5	5	6
90	0	2	3	3	4	4	4	4	5	5	5	5	5

TABLE XVI.

Correction of Alt. of ⊙'s Lower Limb.

Alt.	HEIGHT OF EYE IN FEET.												
	0	4	8	12	16	18	20	22	24	26	28	30	32
6°	8′	6′	5′	4′	4′	3′	3′	3′	3′	3′	2′	2′	2′
7	9	7	6	5	5	5	4	4	4	4	4	3	3
8	10	8	7	6	6	5	5	5	5	5	4	4	4
9	10	8	7	7	6	6	6	6	5	5	5	5	5
10	11	9	8	7	7	7	6	6	6	6	6	5	5
11	11	9	8	8	7	7	7	7	7	6	6	6	6
12	12	10	9	8	8	8	7	7	7	7	6	6	6
13	12	10	9	9	8	8	8	7	7	7	7	7	6
14	12	10	10	9	8	8	8	8	8	8	7	7	7
15	13	11	10	9	9	8	8	8	8	8	8	7	7
16	13	11	10	9	9	9	8	8	8	8	8	7	7
17	13	11	10	10	9	9	9	8	8	8	8	8	7
18	13	11	10	10	9	9	9	9	8	8	8	8	8
19	13	11	10	10	9	9	9	9	9	8	8	8	8
20	13	11	11	10	10	9	9	9	9	9	8	8	8
22	14	12	11	10	10	10	9	9	9	9	9	9	8
26	14	12	11	11	10	10	10	10	9	9	9	9	9
30	14	12	12	11	11	10	10	10	10	9	9	9	9
35	15	13	12	11	11	11	10	10	10	10	10	9	9
40	15	13	12	11	11	11	11	10	10	10	10	10	9
50	15	13	13	12	11	11	11	11	11	10	10	10	10
60	15	13	13	12	12	11	11	11	11	11	10	10	10
70	16	14	13	12	12	12	11	11	11	11	11	11	10
80	16	14	13	12	12	12	12	11	11	11	11	11	11
90	16	14	13	13	12	12	12	12	11	11	11	11	11

TABLE XVII.

Half-Sines & Half-Cosines.

Half-Sines.

M.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	
0	0′ 0″	1′ 27″	2′ 54″	4′ 22″	5′ 49″	7′ 16″	8′ 43″	10′ 9″	11′ 36″	13′ 2″	14′ 28″	15′ 54″	17′ 20″	60
1	0 1	1 29	2 56	4 23	5 50	7 17	8 44	10 11	11 37	13 4	14 30	15 55	17 21	59
2	0 3	1 30	2 57	4 25	5 52	7 19	8 46	10 12	11 39	13 5	14 31	15 57	17 22	58
3	0 4	1 32	2 59	4 26	5 53	7 20	8 47	10 14	11 40	13 6	14 33	15 58	17 24	57
4	0 6	1 33	3 0	4 27	5 55	7 22	8 48	10 15	11 42	13 8	14 34	16 0	17 25	56
5	0 7	1 35	3 2	4 29	5 56	7 23	8 50	10 17	11 43	13 9	14 35	16 1	17 27	55
6	0 9	1 36	3 3	4 30	5 57	7 25	8 51	10 18	11 45	13 11	14 37	16 3	17 28	54
7	0 10	1 37	3 5	4 32	5 59	7 26	8 53	10 19	11 46	13 12	14 38	16 4	17 30	53
8	0 12	1 39	3 6	4 33	6 0	7 27	8 54	10 21	11 47	13 14	14 40	16 5	17 31	52
9	0 13	1 40	3 8	4 35	6 2	7 29	8 56	10 22	11 49	13 15	14 41	16 7	17 32	51
10	0 15	1 42	3 9	4 36	6 3	7 30	8 57	10 24	11 50	13 17	14 43	16 8	17 34	50
11	0 16	1 43	3 11	4 38	6 5	7 32	8 59	10 25	11 52	13 18	14 44	16 10	17 35	49
12	0 17	1 45	3 12	4 39	6 6	7 33	9 0	10 27	11 53	13 19	14 45	16 11	17 37	48
13	0 19	1 46	3 13	4 41	6 8	7 35	9 1	10 28	11 55	13 21	14 47	16 13	17 38	47
14	0 20	1 48	3 15	4 42	6 9	7 36	9 3	10 30	11 56	13 22	14 48	16 14	17 39	46
15	0 22	1 49	3 16	4 43	6 11	7 38	9 4	10 31	11 57	13 24	14 50	16 15	17 41	45
16	0 23	1 51	3 18	4 45	6 12	7 39	9 6	10 32	11 59	13 25	14 51	16 17	17 42	44
17	0 25	1 52	3 19	4 46	6 13	7 40	9 7	10 34	12 0	13 27	14 53	16 18	17 44	43
18	0 26	1 53	3 21	4 48	6 15	7 42	9 9	10 35	12 2	13 28	14 54	16 20	17 45	42
19	0 28	1 55	3 22	4 49	6 16	7 43	9 10	10 37	12 3	13 29	14 55	16 21	17 47	41
20	0 29	1 56	3 24	4 51	6 18	7 45	9 12	10 38	12 5	13 31	14 57	16 23	17 48	40
21	0 31	1 58	3 25	4 52	6 19	7 46	9 13	10 40	12 6	13 32	14 58	16 24	17 49	39
22	0 32	1 59	3 26	4 54	6 21	7 48	9 14	10 41	12 8	13 34	15 0	16 25	17 51	38
23	0 33	2 1	3 28	4 55	6 22	7 49	9 16	10 43	12 9	13 35	15 1	16 27	17 52	37
24	0 35	2 2	3 29	4 57	6 24	7 51	9 17	10 44	12 10	13 37	15 3	16 28	17 54	36
25	0 36	2 4	3 31	4 58	6 25	7 52	9 19	10 45	12 12	13 38	15 4	16 30	17 55	35
26	0 38	2 5	3 32	4 59	6 26	7 53	9 20	10 47	12 13	13 40	15 5	16 31	17 57	34
27	0 39	2 7	3 34	5 1	6 28	7 55	9 22	10 48	12 15	13 41	15 7	16 33	17 58	33
28	0 41	2 8	3 35	5 2	6 29	7 56	9 23	10 50	12 16	13 42	15 8	16 34	17 59	32
29	0 42	2 9	3 37	5 4	6 31	7 58	9 25	10 51	12 18	13 44	15 10	16 35	18 1	31
30	0 44	2 11	3 38	5 5	6 32	7 59	9 26	10 53	12 19	13 45	15 11	16 37	18 2	30
31	0 45	2 12	3 40	5 7	6 34	8 1	9 27	10 54	12 20	13 47	15 13	16 38	18 4	29
32	0 47	2 14	3 41	5 8	6 35	8 2	9 29	10 56	12 22	13 48	15 14	16 40	18 5	28
33	0 48	2 15	3 42	5 10	6 37	8 4	9 30	10 57	12 24	13 50	15 15	16 41	18 6	27
34	0 49	2 17	3 44	5 11	6 38	8 5	9 32	10 58	12 25	13 51	15 17	16 43	18 8	26
35	0 51	2 18	3 45	5 13	6 40	8 6	9 33	11 0	12 26	13 52	15 18	16 44	18 9	25
36	0 52	2 20	3 47	5 14	6 41	8 8	9 35	11 1	12 28	13 54	15 20	16 45	18 11	24
37	0 54	2 21	3 48	5 15	6 42	8 9	9 36	11 3	12 29	13 55	15 21	16 47	18 12	23
38	0 55	2 23	3 50	5 17	6 44	8 11	9 38	11 4	12 30	13 57	15 23	16 48	18 14	22
39	0 57	2 24	3 51	5 18	6 45	8 12	9 39	11 6	12 32	13 58	15 24	16 50	18 15	21
40	0 58	2 25	3 53	5 20	6 47	8 14	9 40	11 7	12 33	14 0	15 25	16 51	18 16	20
41	1 0	2 27	3 54	5 21	6 48	8 15	9 42	11 8	12 35	14 1	15 27	16 53	18 18	19
42	1 1	2 28	3 56	5 23	6 50	8 17	9 43	11 10	12 36	14 2	15 28	16 54	18 19	18
43	1 3	2 30	3 57	5 24	6 51	8 18	9 45	11 11	12 38	14 4	15 30	16 55	18 21	17
44	1 4	2 31	3 58	5 26	6 53	8 19	9 46	11 13	12 39	14 5	15 31	16 57	18 22	16
45	1 5	2 33	4 0	5 27	6 54	8 21	9 48	11 14	12 41	14 7	15 33	16 58	18 23	15
46	1 7	2 34	4 1	5 28	6 55	8 22	9 49	11 16	12 42	14 8	15 34	17 0	18 25	14
47	1 8	2 36	4 3	5 30	6 57	8 24	9 51	11 17	12 43	14 10	15 35	17 1	18 26	13
48	1 10	2 37	4 4	5 31	6 58	8 25	9 52	11 19	12 45	14 11	15 37	17 2	18 28	12
49	1 11	2 39	4 6	5 33	7 0	8 27	9 53	11 20	12 46	14 12	15 38	17 4	18 29	11
50	1 13	2 40	4 7	5 34	7 1	8 28	9 55	11 21	12 48	14 14	15 40	17 5	18 30	10
51	1 14	2 41	4 9	5 36	7 3	8 30	9 56	11 23	12 49	14 15	15 41	17 7	18 32	9
52	1 16	2 43	4 10	5 37	7 4	8 31	9 58	11 24	12 51	14 17	15 43	17 8	18 33	8
53	1 17	2 44	4 12	5 39	7 5	8 33	9 59	11 26	12 52	14 18	15 44	17 10	18 35	7
54	1 19	2 46	4 13	5 40	7 7	8 34	10 1	11 27	12 54	14 20	15 45	17 11	18 36	6
55	1 20	2 47	4 14	5 42	7 9	8 35	10 2	11 29	12 55	14 21	15 47	17 12	18 38	5
56	1 21	2 49	4 16	5 43	7 10	8 37	10 4	11 30	12 56	14 23	15 48	17 14	18 39	4
57	1 23	2 50	4 17	5 44	7 11	8 38	10 5	11 32	12 58	14 24	15 50	17 15	18 41	3
58	1 24	2 52	4 19	5 46	7 13	8 40	10 6	11 33	12 59	14 25	15 51	17 17	18 42	2
59	1 26	2 53	4 20	5 47	7 14	8 41	10 8	11 34	13 1	14 27	15 53	17 18	18 43	1
60	1 27	2 54	4 22	5 49	7 16	8 43	10 9	11 36	13 2	14 28	15 54	17 20	18 45	0
	89°	88°	87°	86°	85°	84°	83°	82°	81°	80°	79°	78°	77°	M.

Half-Cosines.

TABLE XIII.

Correction of Sun's Declination.

Greenwich Time	DECLINATION.																								
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	21½°	22°	22½°	23°	23½°	23¾°
1 h.	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	1′	0′	0′	0′	0′	0′	0′	0′
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	0	0	0	0
3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	0	0
4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	2	2	2	2	1	1	1	1	0
5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	3	3	3	3	2	2	2	1	1	1	0
6	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	4	4	4	4	3	3	2	2	2	1	1	1	0
7	7	7	7	7	7	7	7	7	6	6	6	6	6	6	6	5	5	5	5	4	4	3	3	3	2	1	1	0
8	8	8	8	8	8	8	8	7	7	7	7	7	7	6	6	6	6	5	5	4	4	3	3	2	2	1	1	0
9	9	9	9	9	9	9	8	8	8	8	8	8	7	7	7	7	6	6	5	5	4	4	3	3	2	1	1	0
10	10	10	10	10	10	10	9	9	9	9	9	9	8	8	8	8	7	7	7	6	5	5	4	4	3	2	1	0
11	11	11	11	11	11	11	10	10	10	10	10	9	9	9	9	8	8	8	7	7	6	5	5	4	3	2	2	0
12	12	12	12	12	12	12	11	11	11	11	11	10	10	10	10	9	9	8	8	7	6	5	5	4	4	2	2	0

TABLE XIV.

Correction of the Equation of Time.

Greenwich Time	DAILY VARIATION.																											
	1″	2″	4″	6″	8″	10″	11″	12″	13″	14″	15″	16″	17″	18″	19″	20″	21″	22″	23″	24″	25″	26″	27″	28″	29″	30″	31″	32″
1 h.	0″	0″	0″	0″	0″	0″	0″	0″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	1″	2″	2″
2	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3
3	0	0	0	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4
4	0	0	0	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5
5	0	0	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6	6	6	6
6	0	0	1	1	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8
7	0	1	1	2	2	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	9	9
8	0	1	1	2	3	3	4	4	4	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	
9	0	1	1	2	3	3	4	4	5	5	6	6	6	7	7	7	8	8	9	9	9	10	10	10	11	11	12	12
10	0	1	2	2	3	4	5	5	5	6	6	7	7	7	8	8	9	9	9	10	10	11	11	12	12	12	13	13
11	0	1	2	3	4	5	5	6	6	7	7	8	8	9	9	10	10	10	11	11	12	12	13	13	14	14	15	
12	0	1	2	3	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16

TABLE XV.

Correction of a Star's Altitude.

Alt.	HEIGHT OF EYE IN FEET.													
	0	4	8	12	16	18	20	22	24	26	28	30	32	
6°	8′	10′	11′	12′	12′	13′	13′	13′	13′	13′	14′	14′	14′	
7	7	9	10	11	11	11	12	12	12	12	12	13	13	
8	6	8	9	10	10	11	11	11	11	11	12	12	12	
9	6	8	9	9	10	10	10	11	11	11	11	11	11	
10	5	7	8	9	9	9	10	10	10	10	10	11	11	
11	5	7	8	8	9	9	9	9	9	10	10	10	10	
12	4	6	7	8	8	8	9	9	9	9	10	10	10	
13	4	6	7	7	8	8	8	9	9	9	9	9	10	
14	4	6	6	7	8	8	8	8	8	8	9	9	9	
15	3	5	6	7	7	8	8	8	8	8	8	9	9	
16	3	5	6	7	7	7	8	8	8	8	8	8	9	
17	3	5	6	6	7	7	7	8	8	8	8	8	8	
18	3	5	6	6	7	7	7	7	8	8	8	8	8	
19	3	5	6	6	7	7	7	7	7	8	8	8	8	
20	3	5	5	6	6	7	7	7	7	7	8	8	8	
22	2	4	5	6	6	6	7	7	7	7	7	8	8	
26	2	4	5	5	6	6	6	6	7	7	7	7	7	
30	2	4	4	5	5	6	6	6	6	7	7	7	7	
35	1	3	4	5	5	5	6	6	6	6	6	7	7	
40	1	3	4	5	5	5	5	6	6	6	6	6	7	
50	1	3	3	4	5	5	5	5	5	5	6	6	6	6
60	1	3	3	4	4	5	5	5	5	5	5	6	6	6
70	0	2	3	4	4	4	5	5	5	5	5	5	6	6
80	0	2	3	4	4	4	4	5	5	5	5	5	5	6
90	0	2	3	3	4	4	4	4	5	5	5	5	5	5

TABLE XVI.

Correction of Alt. of ⊙'s Lower Limb.

Alt.	HEIGHT OF EYE IN FEET.												
	0	4	8	12	16	18	20	22	24	26	28	30	32
6°	8′	6′	5′	4′	4′	3′	3′	3′	3′	3′	2′	2′	2′
7	9	7	6	5	5	5	4	4	4	4	4	3	3
8	10	8	7	6	6	5	5	5	5	5	4	4	4
9	10	8	7	7	6	6	6	6	5	5	5	5	5
10	11	9	8	7	7	7	6	6	6	6	6	5	5
11	11	9	8	8	7	7	7	7	7	6	6	6	6
12	12	10	9	8	8	8	7	7	7	7	6	6	6
13	12	10	9	9	8	8	8	7	7	7	7	7	6
14	12	10	10	9	8	8	8	8	8	8	7	7	7
15	13	11	10	9	9	8	8	8	8	8	8	7	7
16	13	11	10	9	9	9	8	8	8	8	8	7	7
17	13	11	10	10	9	9	9	8	8	8	8	8	7
18	13	11	10	10	9	9	9	9	8	8	8	8	8
19	13	11	10	10	9	9	9	9	9	8	8	8	8
20	13	11	11	10	10	9	9	9	9	9	8	8	8
22	14	12	11	10	10	10	9	9	9	9	9	9	8
26	14	12	11	11	10	10	10	9	9	9	9	9	9
30	14	12	12	11	11	10	10	10	10	9	9	9	9
35	15	13	12	11	11	11	10	10	10	10	10	9	9
40	15	13	12	11	11	11	11	10	10	10	10	10	9
50	15	13	13	12	11	11	11	11	11	10	10	10	10
60	15	13	13	12	12	11	11	11	11	11	10	10	10
70	16	14	13	12	12	12	11	11	11	11	11	10	10
80	16	14	13	12	12	12	12	11	11	11	11	11	10
90	16	14	13	13	12	12	12	12	11	11	11	11	11

TABLE XVII.

Half-Sines & Half-Cosines.

Half-Sines.

M.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	
0	0′ 0″	1′ 27″	2′ 54″	4′ 22″	5′ 49″	7′ 16″	8′ 43″	10′ 9″	11′ 36″	13′ 2″	14′ 28″	15′ 54″	17′ 20″	60
1	0 1	1 29	2 56	4 23	5 50	7 17	8 44	10 11	11 37	13 4	14 30	15 55	17 21	59
2	0 3	1 30	2 57	4 25	5 52	7 19	8 46	10 12	11 39	13 5	14 31	15 57	17 22	58
3	0 4	1 32	2 59	4 26	5 53	7 20	8 47	10 14	11 40	13 6	14 33	15 58	17 24	57
4	0 6	1 33	3 0	4 27	5 55	7 22	8 48	10 15	11 42	13 8	14 34	16 0	17 25	56
5	0 7	1 35	3 2	4 29	5 56	7 23	8 50	10 17	11 43	13 9	14 35	16 1	17 27	55
6	0 9	1 36	3 3	4 30	5 57	7 25	8 51	10 18	11 45	13 11	14 37	16 3	17 28	54
7	0 10	1 37	3 5	4 32	5 59	7 26	8 53	10 19	11 46	13 12	14 38	16 4	17 30	53
8	0 12	1 39	3 6	4 33	6 0	7 27	8 54	10 21	11 47	13 14	14 40	16 5	17 31	52
9	0 13	1 40	3 8	4 35	6 2	7 29	8 56	10 22	11 49	13 15	14 41	16 7	17 32	51
10	0 15	1 42	3 9	4 36	6 3	7 30	8 57	10 24	11 50	13 17	14 43	16 8	17 34	50
11	0 16	1 43	3 11	4 38	6 5	7 32	8 59	10 25	11 52	13 18	14 44	16 10	17 35	49
12	0 17	1 45	3 12	4 39	6 6	7 33	9 0	10 27	11 53	13 19	14 45	16 11	17 37	48
13	0 19	1 46	3 13	4 41	6 8	7 35	9 1	10 28	11 55	13 21	14 47	16 13	17 38	47
14	0 20	1 48	3 15	4 42	6 9	7 36	9 3	10 30	11 56	13 22	14 48	16 14	17 39	46
15	0 22	1 49	3 16	4 43	6 11	7 38	9 4	10 31	11 57	13 24	14 50	16 15	17 41	45
16	0 23	1 51	3 18	4 45	6 12	7 39	9 6	10 32	11 59	13 25	14 51	16 17	17 42	44
17	0 25	1 52	3 19	4 46	6 13	7 40	9 7	10 34	12 0	13 27	14 53	16 18	17 44	43
18	0 26	1 53	3 21	4 48	6 15	7 42	9 9	10 35	12 2	13 28	14 54	16 20	17 45	42
19	0 28	1 55	3 22	4 49	6 16	7 43	9 10	10 37	12 3	13 29	14 55	16 21	17 47	41
20	0 29	1 56	3 24	4 51	6 18	7 45	9 12	10 38	12 5	13 31	14 57	16 23	17 48	40
21	0 31	1 58	3 25	4 52	6 19	7 46	9 13	10 40	12 6	13 32	14 58	16 24	17 49	39
22	0 32	1 59	3 26	4 54	6 21	7 48	9 14	10 41	12 8	13 34	15 0	16 25	17 51	38
23	0 33	2 1	3 28	4 55	6 22	7 49	9 16	10 43	12 9	13 35	15 1	16 27	17 52	37
24	0 35	2 2	3 29	4 57	6 24	7 51	9 17	10 44	12 10	13 37	15 3	16 28	17 54	36
25	0 36	2 4	3 31	4 58	6 25	7 52	9 19	10 45	12 12	13 38	15 4	16 30	17 55	35
26	0 38	2 5	3 32	4 59	6 26	7 53	9 20	10 47	12 13	13 40	15 5	16 31	17 57	34
27	0 39	2 7	3 34	5 1	6 28	7 55	9 22	10 48	12 15	13 41	15 7	16 33	17 58	33
28	0 41	2 8	3 35	5 2	6 29	7 56	9 23	10 50	12 16	13 42	15 8	16 34	17 59	32
29	0 42	2 9	3 37	5 4	6 31	7 58	9 25	10 51	12 18	13 44	15 10	16 35	18 1	31
30	0 44	2 11	3 38	5 5	6 32	7 59	9 26	10 53	12 19	13 45	15 11	16 37	18 2	30
31	0 45	2 12	3 40	5 7	6 34	8 1	9 27	10 54	12 20	13 47	15 13	16 38	18 4	29
32	0 47	2 14	3 41	5 8	6 35	8 2	9 29	10 56	12 22	13 48	15 14	16 40	18 5	28
33	0 48	2 15	3 42	5 10	6 37	8 4	9 30	10 57	12 24	13 50	15 15	16 41	18 6	27
34	0 49	2 17	3 44	5 11	6 38	8 5	9 32	10 58	12 25	13 51	15 17	16 43	18 8	26
35	0 51	2 18	3 45	5 13	6 40	8 6	9 33	11 0	12 26	13 52	15 18	16 44	18 9	25
36	0 52	2 20	3 47	5 14	6 41	8 8	9 35	11 1	12 28	13 54	15 20	16 45	18 11	24
37	0 54	2 21	3 48	5 15	6 42	8 9	9 36	11 3	12 29	13 55	15 21	16 47	18 12	23
38	0 55	2 23	3 50	5 17	6 44	8 11	9 38	11 4	12 30	13 57	15 23	16 48	18 14	22
39	0 57	2 24	3 51	5 18	6 45	8 12	9 39	11 6	12 32	13 58	15 24	16 50	18 15	21
40	0 58	2 25	3 53	5 20	6 47	8 14	9 40	11 7	12 33	14 0	15 25	16 51	18 16	20
41	1 0	2 27	3 54	5 21	6 48	8 15	9 42	11 8	12 35	14 1	15 27	16 53	18 18	19
42	1 1	2 28	3 56	5 23	6 50	8 17	9 43	11 10	12 36	14 2	15 28	16 54	18 19	18
43	1 3	2 30	3 57	5 24	6 51	8 18	9 45	11 11	12 38	14 4	15 30	16 55	18 21	17
44	1 4	2 31	3 58	5 26	6 53	8 19	9 46	11 13	12 39	14 5	15 31	16 57	18 22	16
45	1 5	2 33	4 0	5 27	6 54	8 21	9 48	11 14	12 41	14 7	15 33	16 58	18 23	15
46	1 7	2 34	4 1	5 28	6 55	8 22	9 49	11 16	12 42	14 8	15 34	17 0	18 25	14
47	1 8	2 36	4 3	5 30	6 57	8 24	9 51	11 17	12 43	14 10	15 35	17 1	18 26	13
48	1 10	2 37	4 4	5 31	6 58	8 25	9 52	11 19	12 45	14 11	15 37	17 2	18 28	12
49	1 11	2 39	4 6	5 33	7 0	8 27	9 53	11 20	12 46	14 12	15 38	17 4	18 29	11
50	1 13	2 40	4 7	5 34	7 1	8 28	9 55	11 21	12 48	14 14	15 40	17 5	18 30	10
51	1 14	2 41	4 9	5 36	7 3	8 30	9 56	11 23	12 49	14 15	15 41	17 7	18 32	9
52	1 16	2 43	4 10	5 37	7 4	8 31	9 58	11 24	12 51	14 17	15 43	17 8	18 33	8
53	1 17	2 44	4 12	5 39	7 5	8 33	9 59	11 26	12 52	14 18	15 44	17 10	18 35	7
54	1 19	2 46	4 13	5 40	7 7	8 34	10 1	11 27	12 54	14 20	15 45	17 11	18 36	6
55	1 20	2 47	4 14	5 42	7 9	8 35	10 2	11 29	12 55	14 21	15 47	17 12	18 38	5
56	1 21	2 49	4 16	5 43	7 10	8 37	10 4	11 30	12 56	14 23	15 48	17 14	18 39	4
57	1 23	2 50	4 17	5 44	7 11	8 38	10 5	11 32	12 58	14 24	15 50	17 15	18 41	3
58	1 24	2 52	4 19	5 46	7 13	8 40	10 6	11 33	12 59	14 25	15 51	17 17	18 42	2
59	1 26	2 53	4 20	5 47	7 14	8 41	10 8	11 34	13 1	14 27	15 53	17 18	18 43	1
60	1 27	2 54	4 22	5 49	7 16	8 43	10 9	11 36	13 2	14 28	15 54	17 20	18 45	0
	89°	88°	87°	86°	85°	84°	83°	82°	81°	80°	79°	78°	77°	M.

Half-Cosines.

TABLE XVII

Half-Sines & Half-Cosines.

Half-Sines.

M.	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	
0	18′ 45″	20′ 10″	21′ 34″	22′ 58″	24′ 22″	25′ 45″	27′ 8″	28′ 30″	29′ 52″	31′ 13″	32′ 34″	33′ 54″	35′ 13″	60
1	18 46	20 11	21 36	23 0	24 23	25 46	27 9	28 31	29 53	31 14	32 35	33 55	35 14	59
2	18 48	20 12	21 37	23 1	24 25	25 48	27 11	28 33	29 55	31 16	32 36	33 56	35 16	58
3	18 49	20 14	21 38	23 2	24 26	25 49	27 12	28 34	29 56	31 17	32 38	33 58	35 17	57
4	18 50	20 15	21 40	23 4	24 27	25 51	27 13	28 36	29 57	31 18	32 39	33 59	35 18	56
5	18 52	20 17	21 41	23 5	24 29	25 52	27 15	28 37	29 59	31 20	32 40	34 0	35 20	55
6	18 53	20 18	21 43	23 7	24 30	25 53	27 16	28 38	30 0	31 21	32 42	34 2	35 21	54
7	18 55	20 19	21 44	23 8	24 32	25 55	27 17	28 40	30 1	31 22	32 43	34 3	35 22	53
8	18 56	20 21	21 45	23 9	24 33	25 56	27 19	28 41	30 3	31 24	32 45	34 4	35 23	52
9	18 58	20 22	21 47	23 11	24 34	25 58	27 20	28 42	30 4	31 25	32 46	34 6	35 25	51
10	18 59	20 24	21 48	23 12	24 36	25 59	27 22	28 44	30 5	31 27	32 47	34 7	35 26	50
11	19 0	20 25	21 50	23 14	24 37	26 0	27 23	28 45	30 7	31 28	32 48	34 8	35 28	49
12	19 2	20 27	21 51	23 15	24 39	26 2	27 24	28 46	30 8	31 29	32 49	34 10	35 29	48
13	19 3	20 28	21 52	23 16	24 40	26 3	27 26	28 48	30 9	31 31	32 51	34 11	35 30	47
14	19 5	20 29	21 54	23 18	24 41	26 4	27 27	28 49	30 11	31 32	32 52	34 12	35 32	46
15	19 6	20 31	21 55	23 19	24 43	26 6	27 28	28 51	30 12	31 33	32 54	34 14	35 33	45
16	19 7	20 32	21 57	23 21	24 44	26 7	27 30	28 52	30 14	31 35	32 55	34 15	35 34	44
17	19 9	20 34	21 58	23 22	24 45	26 9	27 31	28 53	30 15	31 36	32 56	34 16	35 35	43
18	19 10	20 35	21 59	23 23	24 47	26 10	27 33	28 55	30 16	31 37	32 58	34 18	35 37	42
19	19 12	20 36	22 1	23 25	24 48	26 11	27 34	28 56	30 18	31 39	32 59	34 19	35 38	41
20	19 13	20 38	22 2	23 26	24 50	26 13	27 35	28 57	30 19	31 40	33 0	34 20	35 39	40
21	19 14	20 39	22 4	23 28	24 51	26 14	27 37	28 59	30 20	31 41	33 2	34 22	35 41	39
22	19 16	20 41	22 5	23 29	24 52	26 15	27 38	29 0	30 22	31 43	33 3	34 23	35 42	38
23	19 17	20 42	22 6	23 30	24 54	26 17	27 39	29 1	30 23	31 44	33 4	34 24	35 43	37
24	19 19	20 43	22 8	23 32	24 55	26 18	27 41	29 3	30 24	31 45	33 6	34 26	35 45	36
25	19 20	20 45	22 9	23 33	24 57	26 20	27 42	29 4	30 26	31 47	33 7	34 27	35 46	35
26	19 22	20 46	22 11	23 35	24 58	26 21	27 44	29 6	30 27	31 48	33 8	34 28	35 47	34
27	19 23	20 48	22 12	23 36	24 59	26 22	27 45	29 7	30 28	31 49	33 10	34 29	35 49	33
28	19 24	20 49	22 13	23 37	25 1	26 24	27 46	29 8	30 30	31 51	33 11	34 31	35 50	32
29	19 26	20 50	22 15	23 39	25 2	26 25	27 48	29 10	30 31	31 52	33 12	34 32	35 51	31
30	19 27	20 52	22 16	23 40	25 4	26 27	27 49	29 11	30 33	31 53	33 14	34 33	35 53	30
31	19 29	20 53	22 18	23 41	25 5	26 28	27 50	29 12	30 34	31 55	33 15	34 35	35 54	29
32	19 30	20 55	22 19	23 43	25 6	26 29	27 52	29 14	30 35	31 56	33 16	34 36	35 55	28
33	19 31	20 56	22 20	23 44	25 8	26 31	27 53	29 15	30 37	31 57	33 18	34 37	35 56	27
34	19 33	20 58	22 22	23 46	25 9	26 32	27 55	29 16	30 38	31 59	33 19	34 39	35 58	26
35	19 34	20 59	22 23	23 47	25 10	26 33	27 56	29 18	30 39	32 0	33 20	34 40	35 59	25
36	19 36	21 0	22 25	23 48	25 12	26 35	27 58	29 19	30 41	32 1	33 22	34 41	36 0	24
37	19 37	21 2	22 26	23 50	25 13	26 36	27 59	29 21	30 42	32 3	33 23	34 43	36 2	23
38	19 39	21 3	22 27	23 51	25 15	26 38	28 0	29 22	30 43	32 4	33 24	34 44	36 3	22
39	19 40	21 5	22 29	23 53	25 16	26 39	28 1	29 23	30 45	32 6	33 26	34 45	36 4	21
40	19 41	21 6	22 30	23 54	25 17	26 40	28 3	29 25	30 46	32 7	33 27	34 47	36 6	20
41	19 43	21 7	22 32	23 55	25 19	26 42	28 4	29 26	30 47	32 8	33 28	34 48	36 7	19
42	19 44	21 9	22 33	23 57	25 20	26 43	28 5	29 27	30 49	32 10	33 30	34 49	36 8	18
43	19 46	21 10	22 34	23 58	25 22	26 44	28 7	29 29	30 50	32 11	33 31	34 51	36 10	17
44	19 47	21 12	22 36	24 0	25 23	26 46	28 8	29 30	30 51	32 12	33 32	34 52	36 11	16
45	19 48	21 13	22 37	24 1	25 24	26 47	28 10	29 31	30 53	32 14	33 34	34 53	36 12	15
46	19 50	21 14	22 39	24 2	25 26	26 49	28 11	29 33	30 54	32 15	33 35	34 55	36 14	14
47	19 51	21 16	22 40	24 4	25 27	26 50	28 12	29 34	30 55	32 16	33 36	34 56	36 15	13
48	19 53	21 17	22 41	24 5	25 28	26 51	28 14	29 36	30 57	32 18	33 38	34 57	36 16	12
49	19 54	21 19	22 43	24 7	25 30	26 53	28 15	29 37	30 58	32 19	33 39	34 59	36 17	11
50	19 55	21 20	22 44	24 8	25 31	26 54	28 16	29 38	31 0	32 20	33 40	35 0	36 19	10
51	19 57	21 21	22 46	24 9	25 33	26 55	28 18	29 40	31 1	32 22	33 42	35 1	36 20	9
52	19 58	21 23	22 47	24 11	25 34	26 57	28 19	29 41	31 2	32 23	33 43	35 3	36 21	8
53	20 0	21 24	22 48	24 12	25 35	26 58	28 21	29 42	31 4	32 24	33 44	35 4	36 23	7
54	20 1	21 26	22 50	24 14	25 37	27 0	28 22	29 44	31 5	32 26	33 46	35 5	36 24	6
55	20 3	21 27	22 51	24 15	25 38	27 1	28 23	29 45	31 6	32 27	33 47	35 7	36 25	5
56	20 4	21 28	22 53	24 16	25 40	27 2	28 25	29 46	31 8	32 28	33 48	35 8	36 27	4
57	20 5	21 30	22 54	24 18	25 41	27 4	28 26	29 48	31 9	32 30	33 50	35 9	36 28	3
58	20 7	21 31	22 55	24 19	25 42	27 5	28 27	29 49	31 10	32 31	33 51	35 10	36 29	2
59	20 8	21 33	22 57	24 20	25 44	27 6	28 29	29 50	31 12	32 32	33 52	35 12	36 31	1
60	20 10	21 34	22 58	24 22	25 45	27 8	28 30	29 52	31 13	32 34	33 54	35 13	36 32	0
	76°	75°	74°	73°	72°	71°	70°	69°	68°	67°	66°	65°	64°	M.

Half-Cosines.

TABLE XVII

Half-Sines & Half-Cosines.

Half-Sines.

M.	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	
0	36′ 32″	37′ 50″	39′ 7″	40′ 24″	41′ 40″	42′ 55″	44′ 10″	45′ 23″	46′ 36″	47′ 48″	48′ 59″	50′ 9″	51′ 18″	60
1	36 33	37 51	39 9	40 25	41 41	42 56	44 11	45 24	46 37	47 49	49 0	50 10	51 19	59
2	36 34	37 53	39 10	40 27	41 43	42 58	44 12	45 26	46 38	47 50	49 1	50 11	51 21	58
3	36 36	37 54	39 11	40 28	41 44	42 59	44 13	45 27	46 40	47 51	49 2	50 13	51 22	57
4	36 37	37 55	39 12	40 29	41 45	43 0	44 15	45 28	46 41	47 53	49 4	50 14	51 23	56
5	36 38	37 56	39 14	40 30	41 46	43 1	44 16	45 29	46 42	47 54	49 5	50 15	51 24	55
6	36 40	37 58	39 15	40 32	41 48	43 3	44 17	45 31	46 43	47 55	49 6	50 16	51 25	54
7	36 41	37 59	39 16	40 33	41 49	43 4	44 18	45 32	46 44	47 56	49 7	50 17	51 26	53
8	36 42	38 0	39 18	40 34	41 50	43 5	44 19	45 33	46 46	47 57	49 8	50 18	51 27	52
9	36 44	38 2	39 19	40 35	41 51	43 6	44 21	45 34	46 47	47 59	49 10	50 20	51 29	51
10	36 45	38 3	39 20	40 37	41 53	43 8	44 22	45 35	46 48	48 0	49 11	50 21	51 30	50
11	36 46	38 4	39 21	40 38	41 54	43 9	44 23	45 37	46 49	48 1	49 12	50 22	51 31	49
12	36 48	38 5	39 23	40 39	41 55	43 10	44 24	45 38	46 50	48 2	49 13	50 23	51 32	48
13	36 49	38 7	39 24	40 41	41 56	43 11	44 26	45 39	46 52	48 3	49 14	50 24	51 33	47
14	36 50	38 8	39 25	40 42	41 58	43 13	44 27	45 40	46 53	48 5	49 15	50 25	51 34	46
15	36 51	38 9	39 27	40 43	41 59	43 14	44 28	45 41	46 54	48 6	49 17	50 26	51 35	45
16	36 53	38 11	39 28	40 44	42 0	43 15	44 29	45 43	46 55	48 7	49 18	50 28	51 37	44
17	36 54	38 12	39 29	40 46	42 1	43 16	44 31	45 44	46 56	48 8	49 19	50 29	51 38	43
18	36 55	38 13	39 30	40 47	42 3	43 18	44 32	45 45	46 58	48 9	49 20	50 30	51 39	42
19	36 57	38 15	39 32	40 48	42 4	43 19	44 33	45 46	46 59	48 10	49 21	50 31	51 40	41
20	36 58	38 16	39 33	40 49	42 5	43 20	44 34	45 48	47 0	48 12	49 22	50 32	51 41	40
21	36 59	38 17	39 34	40 51	42 6	43 21	44 35	45 49	47 1	48 13	49 23	50 33	51 42	39
22	37 1	38 18	39 36	40 52	42 8	43 23	44 37	45 50	47 2	48 14	49 25	50 35	51 43	38
23	37 2	38 20	39 37	40 53	42 9	43 24	44 38	45 51	47 4	48 15	49 26	50 36	51 45	37
24	37 3	38 21	39 38	40 55	42 10	43 25	44 39	45 52	47 5	48 16	49 27	50 37	51 46	36
25	37 4	38 22	39 39	40 56	42 11	43 26	44 40	45 54	47 6	48 18	49 28	50 38	51 47	35
26	37 6	38 24	39 41	40 57	42 13	43 28	44 42	45 55	47 7	48 19	49 29	50 39	51 48	34
27	37 7	38 25	39 42	40 58	42 14	43 29	44 43	45 56	47 8	48 20	49 31	50 40	51 49	33
28	37 8	38 26	39 43	41 0	42 15	43 30	44 44	45 57	47 10	48 21	49 32	50 42	51 50	32
29	37 10	38 27	39 45	41 1	42 16	43 31	44 45	45 58	47 11	48 22	49 33	50 43	51 51	31
30	37 11	38 29	39 46	41 2	42 18	43 32	44 47	46 0	47 12	48 24	49 34	50 44	51 53	30
31	37 12	38 30	39 47	41 3	42 19	43 34	44 48	46 1	47 13	48 25	49 35	50 45	51 54	29
32	37 14	38 31	39 48	41 5	42 20	43 35	44 49	46 2	47 14	48 26	49 36	50 46	51 55	28
33	37 15	38 33	39 50	41 6	42 21	43 36	44 50	46 3	47 16	48 27	49 38	50 47	51 56	27
34	37 16	38 34	39 51	41 7	42 23	43 37	44 51	46 5	47 17	48 28	49 39	50 48	51 57	26
35	37 17	38 35	39 52	41 8	42 24	43 39	44 53	46 6	47 18	48 29	49 40	50 50	51 58	25
36	37 19	38 36	39 53	41 10	42 25	43 40	44 54	46 7	47 19	48 31	49 41	50 51	51 59	24
37	37 20	38 38	39 55	41 11	42 26	43 41	44 55	46 8	47 20	48 32	49 42	50 52	52 1	23
38	37 21	38 39	39 56	41 12	42 28	43 42	44 56	46 9	47 22	48 33	49 43	50 53	52 2	22
39	37 23	38 40	39 57	41 14	42 29	43 44	44 58	46 11	47 23	48 34	49 45	50 54	52 3	21
40	37 24	38 42	39 59	41 15	42 30	43 45	44 59	46 12	47 24	48 35	49 46	50 55	52 4	20
41	37 25	38 43	40 0	41 16	42 31	43 46	45 0	46 13	47 25	48 37	49 47	50 56	52 5	19
42	37 27	38 44	40 1	41 17	42 33	43 47	45 1	46 14	47 26	48 38	49 48	50 58	52 6	18
43	37 28	38 45	40 2	41 19	42 34	43 49	45 2	46 15	47 28	48 39	49 49	50 59	52 7	17
44	37 29	38 47	40 4	41 20	42 35	43 50	45 4	46 17	47 29	48 40	49 50	51 0	52 8	16
45	37 30	38 48	40 5	41 21	42 36	43 51	45 5	46 18	47 30	48 41	49 52	51 1	52 10	15
46	37 32	38 49	40 6	41 22	42 38	43 52	45 6	46 19	47 31	48 42	49 53	51 2	52 11	14
47	37 33	38 51	40 7	41 24	42 39	43 54	45 7	46 20	47 32	48 44	49 54	51 3	52 12	13
48	37 34	38 52	40 9	41 25	42 40	43 55	45 9	46 21	47 34	48 45	49 55	51 5	52 13	12
49	37 36	38 53	40 10	41 26	42 41	43 56	45 10	46 23	47 35	48 46	49 56	51 6	52 14	11
50	37 37	38 55	40 11	41 27	42 43	43 57	45 11	46 24	47 36	48 47	49 57	51 7	52 15	10
51	37 38	38 56	40 13	41 29	42 44	43 58	45 12	46 25	47 37	48 48	49 59	51 8	52 16	9
52	37 40	38 57	40 14	41 30	42 45	44 0	45 13	46 26	47 38	48 50	50 0	51 9	52 18	8
53	37 41	38 58	40 15	41 31	42 46	44 1	45 15	46 28	47 40	48 51	50 1	51 10	52 19	7
54	37 42	39 0	40 16	41 32	42 48	44 2	45 16	46 29	47 41	48 52	50 2	51 11	52 20	6
55	37 43	39 1	40 18	41 34	42 49	44 3	45 17	46 30	47 42	48 53	50 3	51 13	52 21	5
56	37 45	39 2	40 19	41 35	42 50	44 5	45 18	46 31	47 43	48 54	50 4	51 14	52 22	4
57	37 46	39 4	40 20	41 36	42 51	44 6	45 20	46 32	47 44	48 55	50 6	51 15	52 23	3
58	37 47	39 5	40 22	41 37	42 53	44 7	45 21	46 34	47 46	48 57	50 7	51 16	52 24	2
59	37 49	39 6	40 23	41 39	42 54	44 8	45 22	46 35	47 47	48 58	50 8	51 17	52 25	1
60	37 50	39 7	40 24	41 40	42 55	44 10	45 23	46 36	47 48	48 59	50 9	51 18	52 27	0
	63°	62°	61°	60°	59°	58°	57°	56°	55°	54°	53°	52°	51°	M.

Half-Cosines.

TABLE XVII.

Half-Sines & Half-Cosines.

Half-Sines.

M.	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°	
0	52′ 27″	53′ 34″	54′ 40″	55′ 46″	56′ 50″	57′ 53″	58′ 56″	59′ 57″	60′ 57″	61′ 56″	62′ 54″	63′ 50″	64′ 46″	60
1	52 28	53 35	54 41	55 47	56 51	57 54	58 57	59 58	60 58	61 57	62 54	63 51	64 47	59
2	52 29	53 36	54 42	55 48	56 52	57 55	58 58	59 59	60 59	61 58	62 55	63 52	64 48	58
3	52 30	53 37	54 44	55 49	56 53	57 56	58 59	60 0	61 0	61 59	62 56	63 53	64 48	57
4	52 31	53 38	54 45	55 50	56 54	57 57	59 0	60 1	61 1	62 0	62 57	63 54	64 49	56
5	52 32	53 40	54 46	55 51	56 55	57 59	59 1	60 2	61 2	62 1	62 58	63 55	64 50	55
6	52 33	53 41	54 47	55 52	56 56	58 0	59 2	60 3	61 3	62 2	62 59	63 56	64 51	54
7	52 35	53 42	54 48	55 53	56 57	58 1	59 3	60 4	61 4	62 3	63 0	63 57	64 52	53
8	52 36	53 43	54 49	55 54	56 59	58 2	59 4	60 5	61 5	62 4	63 1	63 58	64 53	52
9	52 37	53 44	54 50	55 55	57 0	58 3	59 5	60 6	61 6	62 4	63 2	63 59	64 54	51
10	52 38	53 45	54 51	55 56	57 1	58 4	59 6	60 7	61 7	62 5	63 3	64 0	64 55	50
11	52 39	53 46	54 52	55 58	57 2	58 5	59 7	60 8	61 8	62 6	63 4	64 0	64 56	49
12	52 40	53 47	54 53	55 59	57 3	58 6	59 8	60 9	61 9	62 7	63 5	64 1	64 57	48
13	52 41	53 48	54 55	56 0	57 4	58 7	59 9	60 10	61 10	62 8	63 6	64 2	64 58	47
14	52 42	53 50	54 56	56 1	57 5	58 8	59 10	60 11	61 11	62 9	63 7	64 3	64 59	46
15	52 44	53 51	54 57	56 2	57 6	58 9	59 11	60 12	61 12	62 10	63 8	64 4	64 59	45
16	52 45	53 52	54 58	56 3	57 7	58 10	59 12	60 13	61 13	62 11	63 9	64 5	65 0	44
17	52 46	53 53	54 59	56 4	57 8	58 11	59 13	60 14	61 14	62 12	63 10	64 6	65 1	43
18	52 47	53 54	55 0	56 5	57 9	58 12	59 14	60 15	61 15	62 13	63 11	64 7	65 2	42
19	52 48	53 55	55 1	56 6	57 10	58 13	59 15	60 16	61 16	62 14	63 12	64 8	65 3	41
20	52 49	53 56	55 2	56 7	57 11	58 14	59 16	60 17	61 17	62 15	63 13	64 9	65 4	40
21	52 50	53 57	55 3	56 8	57 12	58 15	59 17	60 18	61 18	62 16	63 14	64 10	65 5	39
22	52 51	53 58	55 4	56 9	57 13	58 16	59 18	60 19	61 19	62 17	63 14	64 11	65 6	38
23	52 53	53 59	55 5	56 10	57 14	58 17	59 19	60 20	61 20	62 18	63 15	64 12	65 7	37
24	52 54	54 1	55 7	56 12	57 15	58 18	59 20	60 21	61 20	62 19	63 16	64 13	65 8	36
25	52 55	54 2	55 8	56 13	57 17	58 19	59 21	60 22	61 21	62 20	63 17	64 13	65 9	35
26	52 56	54 3	55 9	56 14	57 18	58 20	59 22	60 23	61 22	62 21	63 18	64 14	65 9	34
27	52 57	54 4	55 10	56 15	57 19	58 21	59 23	60 24	61 23	62 22	63 19	64 15	65 10	33
28	52 58	54 5	55 11	56 16	57 20	58 22	59 24	60 25	61 24	62 23	63 20	64 16	65 11	32
29	52 59	54 6	55 12	56 17	57 21	58 24	59 25	60 26	61 25	62 24	63 21	64 17	65 12	31
30	53 0	54 7	55 13	56 18	57 22	58 25	59 26	60 27	61 26	62 25	63 22	64 18	65 13	30
31	53 2	54 8	55 14	56 19	57 23	58 26	59 27	60 28	61 27	62 26	63 23	64 19	65 14	29
32	53 3	54 9	55 15	56 20	57 24	58 27	59 28	60 29	61 28	62 27	63 24	64 20	65 15	28
33	53 4	54 11	55 16	56 21	57 25	58 28	59 29	60 30	61 29	62 28	63 25	64 21	65 16	27
34	53 5	54 12	55 17	56 22	57 26	58 29	59 30	60 31	61 30	62 29	63 26	64 22	65 17	26
35	53 6	54 13	55 19	56 23	57 27	58 30	59 31	60 32	61 31	62 30	63 27	64 23	65 18	25
36	53 7	54 14	55 20	56 24	57 28	58 31	59 32	60 33	61 32	62 31	63 28	64 24	65 18	24
37	53 8	54 15	55 21	56 25	57 29	58 32	59 33	60 34	61 33	62 32	63 29	64 25	65 19	23
38	53 9	54 16	55 22	56 27	57 30	58 33	59 34	60 35	61 34	62 32	63 30	64 26	65 20	22
39	53 10	54 17	55 23	56 28	57 31	58 34	59 35	60 36	61 35	62 33	63 31	64 26	65 21	21
40	53 12	54 18	55 24	56 29	57 32	58 35	59 36	60 37	61 36	62 34	63 31	64 27	65 22	20
41	53 13	54 19	55 25	56 30	57 33	58 36	59 37	60 38	61 37	62 35	63 32	64 28	65 23	19
42	53 14	54 21	55 26	56 31	57 34	58 37	59 38	60 39	61 38	62 36	63 33	64 29	65 24	18
43	53 15	54 22	55 27	56 32	57 35	58 38	59 39	60 40	61 39	62 37	63 34	64 30	65 25	17
44	53 16	54 23	55 28	56 33	57 37	58 39	59 40	60 41	61 40	62 38	63 35	64 31	65 26	16
45	53 17	54 24	55 29	56 34	57 38	58 40	59 42	60 42	61 41	62 39	63 36	64 32	65 27	15
46	53 18	54 25	55 30	56 35	57 39	58 41	59 43	60 43	61 42	62 40	63 37	64 33	65 27	14
47	53 19	54 26	55 32	56 36	57 40	58 42	59 44	60 44	61 43	62 41	63 38	64 34	65 28	13
48	53 21	54 27	55 33	56 37	57 41	58 43	59 45	60 45	61 44	62 42	63 39	64 35	65 29	12
49	53 22	54 28	55 34	56 38	57 42	58 44	59 46	60 46	61 45	62 43	63 40	64 36	65 30	11
50	53 23	54 29	55 35	56 39	57 43	58 45	59 47	60 47	61 46	62 44	63 41	64 37	65 31	10
51	53 24	54 30	55 36	56 40	57 44	58 46	59 48	60 48	61 47	62 45	63 42	64 37	65 32	9
52	53 25	54 32	55 37	56 41	57 45	58 47	59 49	60 49	61 48	62 46	63 43	64 38	65 33	8
53	53 26	54 33	55 38	56 43	57 46	58 48	59 50	60 50	61 49	62 47	63 44	64 39	65 34	7
54	53 27	54 34	55 39	56 44	57 47	58 49	59 51	60 51	61 50	62 48	63 45	64 40	65 35	6
55	53 28	54 35	55 40	56 45	57 48	58 50	59 52	60 52	61 51	62 49	63 46	64 41	65 36	5
56	53 29	54 36	55 41	56 46	57 49	58 51	59 53	60 53	61 52	62 50	63 46	64 42	65 36	4
57	53 31	54 37	55 42	56 47	57 50	58 52	59 54	60 54	61 53	62 51	63 47	64 43	65 37	3
58	53 32	54 38	55 43	56 48	57 51	58 53	59 55	60 55	61 54	62 52	63 48	64 44	65 38	2
59	53 33	54 39	55 45	56 49	57 52	58 55	59 56	60 56	61 55	62 53	63 49	64 45	65 39	1
60	53 34	54 40	55 46	56 50	57 53	58 56	59 57	60 57	61 56	62 54	63 50	64 46	65 40	0
	50°	49°	48°	47°	46°	45°	44°	43°	42°	41°	40°	39°	38°	M.

Half-Cosines.

TABLE XVII.

Half-Sines & Half-Cosines.

Half-Sines.

M.	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°	64°	
0	65′ 40″	66′ 33″	67′ 25″	68′ 16″	69′ 5″	69′ 53″	70′ 40″	71′ 26″	72′ 10″	72′ 53″	73′ 35″	74′ 15″	74′ 54″	60
1	65 41	66 34	67 26	68 17	69 6	69 54	70 41	71 27	72 11	72 54	73 35	74 16	74 55	59
2	65 42	66 35	67 27	68 17	69 7	69 55	70 42	71 27	72 12	72 55	73 36	74 16	74 55	58
3	65 43	66 36	67 28	68 18	69 8	69 56	70 43	71 28	72 12	72 55	73 37	74 17	74 56	57
4	65 44	66 37	67 29	68 19	69 8	69 57	70 43	71 29	72 13	72 56	73 37	74 18	74 57	56
5	65 45	66 38	67 29	68 20	69 9	69 57	70 44	71 30	72 14	72 57	73 38	74 18	74 57	55
6	65 45	66 38	67 30	68 21	69 10	69 58	70 45	71 30	72 14	72 57	73 39	74 19	74 58	54
7	65 46	66 39	67 31	68 22	69 11	69 59	70 46	71 31	72 15	72 58	73 40	74 20	74 58	53
8	65 47	66 40	67 32	68 22	69 12	70 0	70 46	71 32	72 16	72 59	73 40	74 20	74 59	52
9	65 48	66 41	67 33	68 23	69 12	70 0	70 47	71 33	72 17	72 59	73 41	74 21	75 0	51
10	65 49	66 42	67 34	68 24	69 13	70 1	70 48	71 33	72 17	73 0	73 42	74 22	75 0	50
11	65 50	66 43	67 34	68 25	69 14	70 2	70 49	71 34	72 18	73 1	73 42	74 22	75 1	49
12	65 51	66 44	67 35	68 26	69 15	70 3	70 49	71 35	72 19	73 2	73 43	74 23	75 2	48
13	65 52	66 45	67 36	68 27	69 16	70 4	70 50	71 36	72 20	73 2	73 44	74 24	75 2	47
14	65 53	66 45	67 37	68 27	69 17	70 4	70 51	71 36	72 20	73 3	73 44	74 24	75 3	46
15	65 53	66 46	67 38	68 28	69 17	70 5	70 52	71 37	72 21	73 4	73 45	74 25	75 3	45
16	65 54	66 47	67 39	68 29	69 18	70 6	70 53	71 38	72 22	73 4	73 46	74 26	75 4	44
17	65 55	66 48	67 40	68 30	69 19	70 7	70 53	71 39	72 22	73 5	73 46	74 26	75 5	43
18	65 56	66 49	67 40	68 31	69 20	70 8	70 54	71 39	72 23	73 6	73 47	74 27	75 5	42
19	65 57	66 50	67 41	68 32	69 21	70 8	70 55	71 40	72 24	73 6	73 48	74 28	75 6	41
20	65 58	66 51	67 42	68 32	69 21	70 9	70 56	71 41	72 25	73 7	73 48	74 28	75 7	40
21	65 59	66 51	67 43	68 33	69 22	70 10	70 56	71 41	72 25	73 8	73 49	74 29	75 7	39
22	66 0	66 52	67 44	68 34	69 23	70 11	70 57	71 42	72 26	73 9	73 50	74 29	75 8	38
23	66 1	66 53	67 45	68 35	69 24	70 11	70 58	71 43	72 27	73 9	73 50	74 30	75 9	37
24	66 1	66 54	67 46	68 36	69 25	70 12	70 59	71 44	72 27	73 10	73 51	74 31	75 9	36
25	66 2	66 55	67 47	68 37	69 25	70 13	70 59	71 44	72 28	73 11	73 52	74 31	75 10	35
26	66 3	66 56	67 47	68 37	69 26	70 14	71 0	71 45	72 29	73 11	73 52	74 32	75 10	34
27	66 4	66 57	67 48	68 38	69 27	70 15	71 1	71 46	72 30	73 12	73 53	74 33	75 11	33
28	66 5	66 58	67 49	68 39	69 28	70 15	71 2	71 47	72 30	73 13	73 54	74 33	75 12	32
29	66 6	66 58	67 50	68 40	69 29	70 16	71 2	71 47	72 31	73 13	73 54	74 34	75 12	31
30	66 7	66 59	67 51	68 41	69 29	70 17	71 3	71 48	72 32	73 14	73 55	74 35	75 13	30
31	66 8	67 0	67 51	68 41	69 30	70 18	71 4	71 49	72 32	73 15	73 56	74 35	75 14	29
32	66 9	67 1	67 52	68 42	69 31	70 19	71 5	71 50	72 33	73 15	73 56	74 36	75 14	28
33	66 9	67 2	67 53	68 43	69 32	70 19	71 6	71 50	72 34	73 16	73 57	74 37	75 15	27
34	66 10	67 3	67 54	68 44	69 33	70 20	71 6	71 51	72 35	73 17	73 58	74 37	75 15	26
35	66 11	67 4	67 55	68 45	69 33	70 21	71 7	71 52	72 35	73 18	73 58	74 38	75 16	25
36	66 12	67 4	67 56	68 46	69 34	70 22	71 8	71 53	72 36	73 18	73 59	74 39	75 17	24
37	66 13	67 5	67 56	68 46	69 35	70 22	71 9	71 53	72 37	73 19	74 0	74 39	75 17	23
38	66 14	67 6	67 57	68 47	69 36	70 23	71 9	71 54	72 37	73 20	74 0	74 40	75 18	22
39	66 15	67 7	67 58	68 48	69 37	70 24	71 10	71 55	72 38	73 20	74 1	74 40	75 19	21
40	66 16	67 8	67 59	68 49	69 37	70 25	71 11	71 56	72 39	73 21	74 2	74 41	75 19	20
41	66 16	67 9	68 0	68 50	69 38	70 26	71 12	71 56	72 40	73 22	74 2	74 42	75 20	19
42	66 17	67 10	68 1	68 50	69 39	70 26	71 12	71 57	72 40	73 22	74 3	74 42	75 20	18
43	66 18	67 11	68 2	68 51	69 40	70 27	71 13	71 58	72 41	73 23	74 4	74 43	75 21	17
44	66 19	67 11	68 2	68 52	69 41	70 28	71 14	71 58	72 42	73 24	74 4	74 44	75 22	16
45	66 20	67 12	68 3	68 53	69 41	70 29	71 15	71 59	72 42	73 24	74 5	74 44	75 22	15
46	66 21	67 13	68 4	68 54	69 42	70 29	71 15	72 0	72 43	73 25	74 6	74 45	75 23	14
47	66 22	67 14	68 5	68 55	69 43	70 30	71 16	72 1	72 44	73 26	74 6	74 46	75 24	13
48	66 23	67 15	68 6	68 55	69 44	70 31	71 17	72 1	72 45	73 27	74 7	74 46	75 24	12
49	66 24	67 16	68 7	68 56	69 45	70 32	71 18	72 2	72 45	73 27	74 8	74 47	75 25	11
50	66 24	67 17	68 7	68 57	69 45	70 33	71 18	72 3	72 46	73 28	74 8	74 48	75 26	10
51	66 25	67 17	68 8	68 58	69 46	70 33	71 19	72 4	72 47	73 29	74 9	74 48	75 26	9
52	66 26	67 18	68 9	68 59	69 47	70 34	71 20	72 4	72 47	73 29	74 10	74 49	75 27	8
53	66 27	67 19	68 10	68 59	69 48	70 35	71 21	72 5	72 48	73 30	74 10	74 50	75 27	7
54	66 28	67 20	68 11	69 0	69 49	70 36	71 21	72 6	72 49	73 31	74 11	74 50	75 28	6
55	66 29	67 21	68 12	69 1	69 49	70 36	71 22	72 6	72 50	73 31	74 12	74 51	75 28	5
56	66 30	67 22	68 12	69 2	69 50	70 37	71 23	72 7	72 50	73 32	74 12	74 51	75 29	4
57	66 31	67 23	68 13	69 3	69 51	70 38	71 24	72 8	72 51	73 33	74 13	74 52	75 30	3
58	66 31	67 23	68 14	69 4	69 52	70 39	71 24	72 9	72 52	73 33	74 14	74 53	75 30	2
59	66 32	67 24	68 15	69 4	69 53	70 39	71 25	72 9	72 52	73 34	74 14	74 53	75 31	1
60	66 33	67 25	68 16	69 5	69 53	70 40	71 26	72 10	72 53	73 35	74 15	74 54	75 32	0
	37°	36°	35°	34°	33°	32°	31°	30°	29°	28°	27°	26°	25°	M.

Half-Cosines.

TABLE XVII.

Half-Sines & Half-Cosines.

Half-Sines.

M.	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°	
0	52′ 27″	53′ 34″	54′ 40″	55′ 46″	56′ 50″	57′ 53″	58′ 56″	59′ 57″	60′ 57″	61′ 56″	62′ 54″	63′ 50″	64′ 46″	60
1	52 28	53 35	54 41	55 47	56 51	57 54	58 57	59 58	60 58	61 57	62 54	63 51	64 47	59
2	52 29	53 36	54 42	55 48	56 52	57 55	58 58	59 59	60 59	61 58	62 55	63 52	64 48	58
3	52 30	53 37	54 44	55 49	56 53	57 56	58 59	60 0	61 0	61 59	62 56	63 53	64 48	57
4	52 31	53 38	54 45	55 50	56 54	57 57	59 0	60 1	61 1	62 0	62 57	63 54	64 49	56
5	52 32	53 40	54 46	55 51	56 55	57 59	59 1	60 2	61 2	62 1	62 58	63 55	64 50	55
6	52 33	53 41	54 47	55 52	56 56	58 0	59 2	60 3	61 3	62 2	62 59	63 56	64 51	54
7	52 35	53 42	54 48	55 53	56 57	58 1	59 3	60 4	61 4	62 3	63 0	63 57	64 52	53
8	52 36	53 43	54 49	55 54	56 59	58 2	59 4	60 5	61 5	62 4	63 1	63 58	64 53	52
9	52 37	53 44	54 50	55 55	57 0	58 3	59 5	60 6	61 6	62 4	63 2	63 59	64 54	51
10	52 38	53 45	54 51	55 56	57 1	58 4	59 6	60 7	61 7	62 5	63 3	64 0	64 55	50
11	52 39	53 46	54 52	55 58	57 2	58 5	59 7	60 8	61 8	62 6	63 4	64 0	64 56	49
12	52 40	53 47	54 53	55 59	57 3	58 6	59 8	60 9	61 9	62 7	63 5	64 1	64 57	48
13	52 41	53 48	54 55	56 0	57 4	58 7	59 9	60 10	61 10	62 8	63 6	64 2	64 58	47
14	52 42	53 50	54 56	56 1	57 5	58 8	59 10	60 11	61 11	62 9	63 7	64 3	64 59	46
15	52 44	53 51	54 57	56 2	57 6	58 9	59 11	60 12	61 12	62 10	63 8	64 4	64 59	45
16	52 45	53 52	54 58	56 3	57 7	58 10	59 12	60 13	61 13	62 11	63 9	64 5	65 0	44
17	52 46	53 53	54 59	56 4	57 8	58 11	59 13	60 14	61 14	62 12	63 10	64 6	65 1	43
18	52 47	53 54	55 0	56 5	57 9	58 12	59 14	60 15	61 15	62 13	63 11	64 7	65 2	42
19	52 48	53 55	55 1	56 6	57 10	58 13	59 15	60 16	61 16	62 14	63 12	64 8	65 3	41
20	52 49	53 56	55 2	56 7	57 11	58 14	59 16	60 17	61 17	62 15	63 13	64 9	65 4	40
21	52 50	53 57	55 3	56 8	57 12	58 15	59 17	60 18	61 18	62 16	63 14	64 10	65 5	39
22	52 51	53 58	55 4	56 9	57 13	58 16	59 18	60 19	61 19	62 17	63 14	64 11	65 6	38
23	52 53	53 59	55 5	56 10	57 14	58 17	59 19	60 20	61 20	62 18	63 15	64 12	65 7	37
24	52 54	54 1	55 7	56 12	57 15	58 18	59 20	60 21	61 20	62 19	63 16	64 13	65 8	36
25	52 55	54 2	55 8	56 13	57 17	58 19	59 21	60 22	61 21	62 20	63 17	64 13	65 9	35
26	52 56	54 3	55 9	56 14	57 18	58 20	59 22	60 23	61 22	62 21	63 18	64 14	65 9	34
27	52 57	54 4	55 10	56 15	57 19	58 21	59 23	60 24	61 23	62 22	63 19	64 15	65 10	33
28	52 58	54 5	55 11	56 16	57 20	58 22	59 24	60 25	61 24	62 23	63 20	64 16	65 11	32
29	52 59	54 6	55 12	56 17	57 21	58 24	59 25	60 26	61 25	62 24	63 21	64 17	65 12	31
30	53 0	54 7	55 13	56 18	57 22	58 25	59 26	60 27	61 26	62 25	63 22	64 18	65 13	30
31	53 2	54 8	55 14	56 19	57 23	58 26	59 27	60 28	61 27	62 26	63 23	64 19	65 14	29
32	53 3	54 9	55 15	56 20	57 24	58 27	59 28	60 29	61 28	62 27	63 24	64 20	65 15	28
33	53 4	54 11	55 16	56 21	57 25	58 28	59 29	60 30	61 29	62 28	63 25	64 21	65 16	27
34	53 5	54 12	55 17	56 22	57 26	58 29	59 30	60 31	61 30	62 29	63 26	64 22	65 17	26
35	53 6	54 13	55 19	56 23	57 27	58 30	59 31	60 32	61 31	62 30	63 27	64 23	65 18	25
36	53 7	54 14	55 20	56 24	57 28	58 31	59 32	60 33	61 32	62 31	63 28	64 24	65 18	24
37	53 8	54 15	55 21	56 25	57 29	58 32	59 33	60 34	61 33	62 32	63 29	64 25	65 19	23
38	53 9	54 16	55 22	56 27	57 30	58 33	59 34	60 35	61 34	62 32	63 30	64 26	65 20	22
39	53 10	54 17	55 23	56 28	57 31	58 34	59 35	60 36	61 35	62 33	63 31	64 26	65 21	21
40	53 12	54 18	55 24	56 29	57 32	58 35	59 36	60 37	61 36	62 34	63 31	64 27	65 22	20
41	53 13	54 19	55 25	56 30	57 33	58 36	59 37	60 38	61 37	62 35	63 32	64 28	65 23	19
42	53 14	54 21	55 26	56 31	57 34	58 37	59 38	60 39	61 38	62 36	63 33	64 29	65 24	18
43	53 15	54 22	55 27	56 32	57 35	58 38	59 39	60 40	61 39	62 37	63 34	64 30	65 25	17
44	53 16	54 23	55 28	56 33	57 37	58 39	59 40	60 41	61 40	62 38	63 35	64 31	65 26	16
45	53 17	54 24	55 29	56 34	57 38	58 40	59 42	60 42	61 41	62 39	63 36	64 32	65 27	15
46	53 18	54 25	55 30	56 35	57 39	58 41	59 43	60 43	61 42	62 40	63 37	64 33	65 27	14
47	53 19	54 26	55 32	56 36	57 40	58 42	59 44	60 44	61 43	62 41	63 38	64 34	65 28	13
48	53 21	54 27	55 33	56 37	57 41	58 43	59 45	60 45	61 44	62 42	63 39	64 35	65 29	12
49	53 22	54 28	55 34	56 38	57 42	58 44	59 46	60 46	61 45	62 43	63 40	64 36	65 30	11
50	53 23	54 29	55 35	56 39	57 43	58 45	59 47	60 47	61 46	62 44	63 41	64 37	65 31	10
51	53 24	54 30	55 36	56 40	57 44	58 46	59 48	60 48	61 47	62 45	63 42	64 37	65 32	9
52	53 25	54 32	55 37	56 41	57 45	58 47	59 49	60 49	61 48	62 46	63 43	64 38	65 33	8
53	53 26	54 33	55 38	56 43	57 46	58 48	59 50	60 50	61 49	62 47	63 44	64 39	65 34	7
54	53 27	54 34	55 39	56 44	57 47	58 49	59 51	60 51	61 50	62 48	63 45	64 40	65 35	6
55	53 28	54 35	55 40	56 45	57 48	58 50	59 52	60 52	61 51	62 49	63 46	64 41	65 36	5
56	53 29	54 36	55 41	56 46	57 49	58 51	59 53	60 53	61 52	62 50	63 46	64 42	65 36	4
57	53 31	54 37	55 42	56 47	57 50	58 52	59 54	60 54	61 53	62 51	63 47	64 43	65 37	3
58	53 32	54 38	55 43	56 48	57 51	58 53	59 55	60 55	61 54	62 52	63 48	64 44	65 38	2
59	53 33	54 39	55 45	56 49	57 52	58 55	59 56	60 56	61 55	62 53	63 49	64 45	65 39	1
60	53 34	54 40	55 46	56 50	57 53	58 56	59 57	60 57	61 56	62 54	63 50	64 46	65 40	0
	50°	49°	48°	47°	46°	45°	44°	43°	42°	41°	40°	39°	38°	M.

Half-Cosines.

TABLE XVII.

Half-Sines & Half-Cosines.

Half-Sines.

M.	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°	64°	
0	65′ 40″	66′ 33″	67′ 25″	68′ 16″	69′ 5″	69′ 53″	70′ 40″	71′ 26″	72′ 10″	72′ 53″	73′ 35″	74′ 15″	74′ 54″	60
1	65 41	66 34	67 26	68 17	69 6	69 54	70 41	71 27	72 11	72 54	73 35	74 16	74 55	59
2	65 42	66 35	67 27	68 17	69 7	69 55	70 42	71 27	72 12	72 55	73 36	74 16	74 55	58
3	65 43	66 36	67 28	68 18	69 8	69 56	70 43	71 28	72 12	72 55	73 37	74 17	74 56	57
4	65 44	66 37	67 29	68 19	69 8	69 57	70 43	71 29	72 13	72 56	73 37	74 18	74 57	56
5	65 45	66 38	67 29	68 20	69 9	69 57	70 44	71 30	72 14	72 57	73 38	74 18	74 57	55
6	65 45	66 38	67 30	68 21	69 10	69 58	70 45	71 30	72 14	72 57	73 39	74 19	74 58	54
7	65 46	66 39	67 31	68 22	69 11	69 59	70 46	71 31	72 15	72 58	73 40	74 20	74 58	53
8	65 47	66 40	67 32	68 22	69 12	70 0	70 46	71 32	72 16	72 59	73 40	74 20	74 59	52
9	65 48	66 41	67 33	68 23	69 12	70 0	70 47	71 33	72 17	72 59	73 41	74 21	75 0	51
10	65 49	66 42	67 34	68 24	69 13	70 1	70 48	71 33	72 17	73 0	73 42	74 22	75 0	50
11	65 50	66 43	67 34	68 25	69 14	70 2	70 49	71 34	72 18	73 1	73 42	74 22	75 1	49
12	65 51	66 44	67 35	68 26	69 15	70 3	70 49	71 35	72 19	73 2	73 43	74 23	75 2	48
13	65 52	66 45	67 36	68 27	69 16	70 4	70 50	71 36	72 20	73 2	73 44	74 24	75 2	47
14	65 53	66 45	67 37	68 27	69 17	70 4	70 51	71 36	72 20	73 3	73 44	74 24	75 3	46
15	65 53	66 46	67 38	68 28	69 17	70 5	70 52	71 37	72 21	73 4	73 45	74 25	75 3	45
16	65 54	66 47	67 39	68 29	69 18	70 6	70 53	71 38	72 22	73 4	73 46	74 26	75 4	44
17	65 55	66 48	67 40	68 30	69 19	70 7	70 53	71 39	72 22	73 5	73 46	74 26	75 5	43
18	65 56	66 49	67 40	68 31	69 20	70 8	70 54	71 39	72 23	73 6	73 47	74 27	75 5	42
19	65 57	66 50	67 41	68 32	69 21	70 8	70 55	71 40	72 24	73 6	73 48	74 28	75 6	41
20	65 58	66 51	67 42	68 32	69 21	70 9	70 56	71 41	72 25	73 7	73 48	74 28	75 7	40
21	65 59	66 51	67 43	68 33	69 22	70 10	70 56	71 41	72 25	73 8	73 49	74 29	75 7	39
22	66 0	66 52	67 44	68 34	69 23	70 11	70 57	71 42	72 26	73 9	73 50	74 29	75 8	38
23	66 1	66 53	67 45	68 35	69 24	70 11	70 58	71 43	72 27	73 9	73 50	74 30	75 9	37
24	66 1	66 54	67 46	68 36	69 25	70 12	70 59	71 44	72 27	73 10	73 51	74 31	75 9	36
25	66 2	66 55	67 47	68 37	69 25	70 13	70 59	71 44	72 28	73 11	73 52	74 31	75 10	35
26	66 3	66 56	67 47	68 37	69 26	70 14	71 0	71 45	72 29	73 11	73 52	74 32	75 10	34
27	66 4	66 57	67 48	68 38	69 27	70 15	71 1	71 46	72 30	73 12	73 53	74 33	75 11	33
28	66 5	66 58	67 49	68 39	69 28	70 15	71 2	71 47	72 30	73 13	73 54	74 33	75 12	32
29	66 6	66 58	67 50	68 40	69 29	70 16	71 2	71 47	72 31	73 13	73 54	74 34	75 12	31
30	66 7	66 59	67 51	68 41	69 29	70 17	71 3	71 48	72 32	73 14	73 55	74 35	75 13	30
31	66 8	67 0	67 51	68 41	69 30	70 18	71 4	71 49	72 32	73 15	73 56	74 35	75 14	29
32	66 9	67 1	67 52	68 42	69 31	70 19	71 5	71 50	72 33	73 15	73 56	74 36	75 14	28
33	66 9	67 2	67 53	68 43	69 32	70 19	71 6	71 50	72 34	73 16	73 57	74 37	75 15	27
34	66 10	67 3	67 54	68 44	69 33	70 20	71 6	71 51	72 35	73 17	73 58	74 37	75 15	26
35	66 11	67 4	67 55	68 45	69 33	70 21	71 7	71 52	72 35	73 18	73 58	74 38	75 16	25
36	66 12	67 4	67 56	68 46	69 34	70 22	71 8	71 53	72 36	73 18	73 59	74 39	75 17	24
37	66 13	67 5	67 56	68 46	69 35	70 22	71 9	71 53	72 37	73 19	74 0	74 39	75 17	23
38	66 14	67 6	67 57	68 47	69 36	70 23	71 9	71 54	72 37	73 20	74 0	74 40	75 18	22
39	66 15	67 7	67 58	68 48	69 37	70 24	71 10	71 55	72 38	73 20	74 1	74 40	75 19	21
40	66 16	67 8	67 59	68 49	69 37	70 25	71 11	71 56	72 39	73 21	74 2	74 41	75 19	20
41	66 16	67 9	68 0	68 50	69 38	70 26	71 12	71 56	72 40	73 22	74 2	74 42	75 20	19
42	66 17	67 10	68 1	68 50	69 39	70 26	71 12	71 57	72 40	73 22	74 3	74 42	75 20	18
43	66 18	67 11	68 2	68 51	69 40	70 27	71 13	71 58	72 41	73 23	74 4	74 43	75 21	17
44	66 19	67 11	68 2	68 52	69 41	70 28	71 14	71 58	72 42	73 24	74 4	74 44	75 22	16
45	66 20	67 12	68 3	68 53	69 41	70 29	71 15	71 59	72 42	73 24	74 5	74 44	75 22	15
46	66 21	67 13	68 4	68 54	69 42	70 29	71 15	72 0	72 43	73 25	74 6	74 45	75 23	14
47	66 22	67 14	68 5	68 55	69 43	70 30	71 16	72 1	72 44	73 26	74 6	74 46	75 24	13
48	66 23	67 15	68 6	68 55	69 44	70 31	71 17	72 1	72 45	73 27	74 7	74 46	75 24	12
49	66 24	67 16	68 7	68 56	69 45	70 32	71 18	72 2	72 45	73 27	74 8	74 47	75 25	11
50	66 24	67 17	68 7	68 57	69 45	70 33	71 18	72 3	72 46	73 28	74 8	74 48	75 26	10
51	66 25	67 17	68 8	68 58	69 46	70 33	71 19	72 4	72 47	73 29	74 9	74 48	75 26	9
52	66 26	67 18	68 9	68 59	69 47	70 34	71 20	72 4	72 47	73 29	74 10	74 49	75 27	8
53	66 27	67 19	68 10	68 59	69 48	70 35	71 21	72 5	72 48	73 30	74 10	74 50	75 27	7
54	66 28	67 20	68 11	69 0	69 49	70 36	71 21	72 6	72 49	73 31	74 11	74 50	75 28	6
55	66 29	67 21	68 12	69 1	69 49	70 36	71 22	72 6	72 50	73 31	74 12	74 51	75 28	5
56	66 30	67 22	68 12	69 2	69 50	70 37	71 23	72 7	72 50	73 32	74 12	74 51	75 29	4
57	66 31	67 23	68 13	69 3	69 51	70 38	71 24	72 8	72 51	73 33	74 13	74 52	75 30	3
58	66 31	67 23	68 14	69 4	69 52	70 39	71 24	72 9	72 52	73 33	74 14	74 53	75 30	2
59	66 32	67 24	68 15	69 4	69 53	70 39	71 25	72 9	72 52	73 34	74 14	74 53	75 31	1
60	66 33	67 25	68 16	69 5	69 53	70 40	71 26	72 10	72 53	73 35	74 15	74 54	75 32	0
	37°	36°	35°	34°	33°	32°	31°	30°	29°	28°	27°	26°	25°	M.

Half-Cosines.

TABLE XVII.

Half-Sines & Half-Cosines.

Half-Sines.

M.	65°	66°	67°	68°	69°	70°	71°	72°	73°	74°	75°	76°	77°	
0	75′ 32″	76′ 8″	76′ 43″	77′ 16″	77′ 48″	78′ 18″	78′ 48″	79′ 15″	79′ 42″	80′ 6″	80′ 30″	80′ 51″	81′ 12″	60
1	75 32	76 8	76 43	77 16	77 48	78 19	78 48	79 16	79 42	80 7	80 30	80 52	81 12	59
2	75 33	76 9	76 44	77 17	77 49	78 19	78 49	79 16	79 42	80 7	80 30	80 52	81 13	58
3	75 33	76 10	76 44	77 18	77 49	78 20	78 49	79 17	79 43	80 8	80 31	80 53	81 13	57
4	75 34	76 10	76 45	77 18	77 50	78 20	78 49	79 17	79 43	80 8	80 31	80 53	81 13	56
5	75 35	76 11	76 45	77 19	77 51	78 21	78 50	79 18	79 44	80 8	80 32	80 53	81 13	55
6	75 35	76 11	76 46	77 19	77 51	78 21	78 50	79 18	79 44	80 9	80 32	80 54	81 14	54
7	75 36	76 12	76 46	77 20	77 52	78 22	78 51	79 18	79 44	80 9	80 32	80 54	81 14	53
8	75 36	76 12	76 47	77 20	77 52	78 22	78 51	79 19	79 45	80 10	80 33	80 54	81 14	52
9	75 37	76 13	76 48	77 21	77 53	78 23	78 52	79 19	79 45	80 10	80 33	80 55	81 15	51
10	75 38	76 14	76 48	77 21	77 53	78 23	78 52	79 20	79 46	80 10	80 33	80 55	81 15	50
11	75 38	76 14	76 49	77 22	77 54	78 24	78 53	79 20	79 46	80 11	80 34	80 55	81 15	49
12	75 39	76 15	76 49	77 22	77 54	78 24	78 53	79 21	79 47	80 11	80 34	80 56	81 16	48
13	75 39	76 15	76 50	77 23	77 55	78 25	78 54	79 21	79 47	80 11	80 34	80 56	81 16	47
14	75 40	76 16	76 50	77 24	77 55	78 25	78 54	79 22	79 47	80 12	80 35	80 56	81 16	46
15	75 41	76 17	76 51	77 24	77 56	78 26	78 55	79 22	79 48	80 12	80 35	80 57	81 17	45
16	75 41	76 17	76 52	77 25	77 56	78 26	78 55	79 22	79 48	80 13	80 36	80 57	81 17	44
17	75 42	76 18	76 52	77 25	77 57	78 27	78 56	79 23	79 49	80 13	80 36	80 57	81 17	43
18	75 43	76 18	76 53	77 26	77 57	78 27	78 56	79 23	79 49	80 13	80 36	80 58	81 18	42
19	75 43	76 19	76 53	77 26	77 58	78 28	78 57	79 24	79 50	80 14	80 37	80 58	81 18	41
20	75 44	76 19	76 54	77 27	77 58	78 28	78 57	79 24	79 50	80 14	80 37	80 58	81 18	40
21	75 44	76 20	76 54	77 27	77 59	78 29	78 57	79 25	79 50	80 15	80 37	80 59	81 19	39
22	75 45	76 21	76 55	77 28	77 59	78 29	78 58	79 25	79 51	80 15	80 38	80 59	81 19	38
23	75 46	76 21	76 55	77 28	78 0	78 30	78 58	79 26	79 51	80 15	80 38	80 59	81 19	37
24	75 46	76 22	76 56	77 29	78 0	78 30	78 59	79 26	79 52	80 16	80 39	81 0	81 20	36
25	75 47	76 22	76 57	77 29	78 1	78 31	78 59	79 26	79 52	80 16	80 39	81 0	81 20	35
26	75 47	76 23	76 57	77 30	78 1	78 31	79 0	79 27	79 52	80 17	80 39	81 0	81 20	34
27	75 48	76 24	76 58	77 30	78 2	78 32	79 0	79 27	79 53	80 17	80 40	81 1	81 21	33
28	75 49	76 24	76 58	77 31	78 2	78 32	79 1	79 28	79 53	80 17	80 40	81 1	81 21	32
29	75 49	76 25	76 59	77 32	78 3	78 33	79 1	79 28	79 54	80 18	80 40	81 2	81 21	31
30	75 50	76 25	76 59	77 32	78 3	78 33	79 2	79 29	79 54	80 18	80 41	81 2	81 21	30
31	75 50	76 26	77 0	77 33	78 4	78 34	79 2	79 29	79 55	80 19	80 41	81 2	81 22	29
32	75 51	76 26	77 1	77 33	78 4	78 34	79 3	79 29	79 55	80 19	80 41	81 3	81 22	28
33	75 52	76 27	77 1	77 34	78 5	78 35	79 3	79 30	79 55	80 19	80 42	81 3	81 22	27
34	75 52	76 28	77 2	77 34	78 5	78 35	79 3	79 30	79 56	80 20	80 42	81 3	81 23	26
35	75 53	76 28	77 2	77 35	78 6	78 36	79 4	79 31	79 56	80 20	80 43	81 4	81 23	25
36	75 53	76 29	77 3	77 35	78 6	78 36	79 4	79 31	79 57	80 20	80 43	81 4	81 23	24
37	75 54	76 29	77 3	77 36	78 7	78 37	79 5	79 32	79 57	80 21	80 43	81 4	81 24	23
38	75 55	76 30	77 4	77 36	78 7	78 37	79 5	79 32	79 57	80 21	80 44	81 5	81 24	22
39	75 55	76 31	77 4	77 37	78 8	78 38	79 6	79 33	79 58	80 22	80 44	81 5	81 24	21
40	75 56	76 31	77 5	77 37	78 8	78 38	79 6	79 33	79 58	80 22	80 44	81 5	81 25	20
41	75 56	76 32	77 5	77 38	78 9	78 39	79 7	79 33	79 59	80 22	80 45	81 6	81 25	19
42	75 57	76 32	77 6	77 38	78 9	78 39	79 7	79 34	79 59	80 23	80 45	81 6	81 25	18
43	75 58	76 33	77 7	77 39	78 10	78 39	79 8	79 34	79 59	80 23	80 45	81 6	81 26	17
44	75 58	76 33	77 7	77 40	78 10	78 40	79 8	79 35	80 0	80 24	80 46	81 7	81 26	16
45	75 59	76 34	77 8	77 40	78 11	78 40	79 8	79 35	80 0	80 24	80 46	81 7	81 26	15
46	75 59	76 35	77 8	77 41	78 11	78 41	79 9	79 36	80 1	80 24	80 47	81 7	81 26	14
47	76 0	76 35	77 9	77 41	78 12	78 41	79 9	79 36	80 1	80 25	80 47	81 8	81 27	13
48	76 1	76 36	77 9	77 42	78 12	78 42	79 10	79 36	80 1	80 25	80 47	81 8	81 27	12
49	76 1	76 36	77 10	77 42	78 13	78 42	79 10	79 37	80 2	80 25	80 48	81 8	81 27	11
50	76 2	76 37	77 10	77 43	78 13	78 43	79 11	79 37	80 2	80 26	80 48	81 9	81 28	10
51	76 2	76 37	77 11	77 43	78 14	78 43	79 11	79 38	80 3	80 26	80 48	81 9	81 28	9
52	76 3	76 38	77 12	77 44	78 14	78 44	79 12	79 38	80 3	80 27	80 49	81 9	81 28	8
53	76 4	76 39	77 12	77 44	78 15	78 44	79 12	79 39	80 3	80 27	80 49	81 10	81 29	7
54	76 4	76 39	77 13	77 45	78 15	78 45	79 13	79 39	80 4	80 27	80 49	81 10	81 29	6
55	76 5	76 40	77 13	77 45	78 16	78 45	79 13	79 39	80 4	80 28	80 50	81 10	81 29	5
56	76 5	76 40	77 14	77 46	78 16	78 46	79 13	79 40	80 5	80 28	80 50	81 11	81 30	4
57	76 6	76 41	77 14	77 46	78 17	78 46	79 14	79 40	80 5	80 29	80 50	81 11	81 30	3
58	76 7	76 41	77 15	77 47	78 17	78 47	79 14	79 41	80 6	80 29	80 51	81 11	81 30	2
59	76 7	76 42	77 15	77 47	78 18	78 47	79 15	79 41	80 6	80 29	80 51	81 12	81 30	1
60	76 8	76 43	77 16	77 48	78 18	78 48	79 15	79 42	80 6	80 30	80 51	81 12	81 31	0
	24°	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	M.

Half-Cosines.

TABLE XVII.

Half-Sines & Half-Cosines.

Half-Sines.

M.	78°	79°	80°	81°	82°	83°	84°	85°	86°	87°	88°	89°	
0	81′ 31″	81′ 48″	82′ 4″	82′ 18″	82′ 31″	82′ 43″	82′ 53″	83′ 1″	83′ 8″	83′ 13″	83′ 17″	83′ 19″	60
1	81 31	81 48	82 4	82 19	82 32	82 43	82 53	83 1	83 8	83 13	83 17	83 19	59
2	81 31	81 49	82 5	82 19	82 32	82 43	82 53	83 1	83 8	83 13	83 17	83 19	58
3	81 32	81 49	82 5	82 19	82 32	82 43	82 53	83 1	83 8	83 13	83 17	83 19	57
4	81 32	81 49	82 5	82 19	82 32	82 43	82 53	83 1	83 8	83 13	83 17	83 19	56
5	81 32	81 50	82 5	82 20	82 32	82 44	82 53	83 2	83 8	83 14	83 17	83 19	55
6	81 33	81 50	82 6	82 20	82 33	82 44	82 54	83 2	83 8	83 14	83 17	83 19	54
7	81 33	81 50	82 6	82 20	82 33	82 44	82 54	83 2	83 9	83 14	83 17	83 19	53
8	81 33	81 50	82 6	82 20	82 33	82 44	82 54	83 2	83 9	83 14	83 17	83 19	52
9	81 33	81 51	82 6	82 20	82 33	82 44	82 54	83 2	83 9	83 14	83 17	83 19	51
10	81 34	81 51	82 7	82 21	82 33	82 44	82 54	83 2	83 9	83 14	83 17	83 19	50
11	81 34	81 51	82 7	82 21	82 34	82 45	82 54	83 2	83 9	83 14	83 17	83 19	49
12	81 34	81 51	82 7	82 21	82 34	82 45	82 54	83 2	83 9	83 14	83 18	83 20	48
13	81 35	81 52	82 7	82 21	82 34	82 45	82 55	83 3	83 9	83 14	83 18	83 20	47
14	81 35	81 52	82 8	82 22	82 34	82 45	82 55	83 3	83 9	83 14	83 18	83 20	46
15	81 35	81 52	82 8	82 22	82 34	82 45	82 55	83 3	83 9	83 14	83 18	83 20	45
16	81 36	81 53	82 8	82 22	82 35	82 46	82 55	83 3	83 9	83 14	83 18	83 20	44
17	81 36	81 53	82 8	82 22	82 35	82 46	82 55	83 3	83 9	83 14	83 18	83 20	43
18	81 36	81 53	82 9	82 22	82 35	82 46	82 55	83 3	83 10	83 14	83 18	83 20	42
19	81 36	81 53	82 9	82 23	82 35	82 46	82 55	83 3	83 10	83 15	83 18	83 20	41
20	81 37	81 54	82 9	82 23	82 35	82 46	82 56	83 3	83 10	83 15	83 18	83 20	40
21	81 37	81 54	82 9	82 23	82 36	82 46	82 56	83 4	83 10	83 15	83 18	83 20	39
22	81 37	81 54	82 9	82 23	82 36	82 47	82 56	83 4	83 10	83 15	83 18	83 20	38
23	81 38	81 54	82 10	82 24	82 36	82 47	82 56	83 4	83 10	83 15	83 18	83 20	37
24	81 38	81 55	82 10	82 24	82 36	82 47	82 56	83 4	83 10	83 15	83 18	83 20	36
25	81 38	81 55	82 10	82 24	82 36	82 47	82 56	83 4	83 10	83 15	83 18	83 20	35
26	81 38	81 55	82 10	82 24	82 36	82 47	82 56	83 4	83 10	83 15	83 18	83 20	34
27	81 39	81 55	82 11	82 24	82 37	82 47	82 57	83 4	83 10	83 15	83 18	83 20	33
28	81 39	81 56	82 11	82 25	82 37	82 48	82 57	83 4	83 10	83 15	83 18	83 20	32
29	81 39	81 56	82 11	82 25	82 37	82 48	82 57	83 4	83 11	83 15	83 18	83 20	31
30	81 40	81 56	82 11	82 25	82 37	82 48	82 57	83 5	83 11	83 15	83 18	83 20	30
31	81 40	81 57	82 12	82 25	82 37	82 48	82 57	83 5	83 11	83 15	83 18	83 20	29
32	81 40	81 57	82 12	82 26	82 38	82 48	82 57	83 5	83 11	83 15	83 18	83 20	28
33	81 40	81 57	82 12	82 26	82 38	82 48	82 57	83 5	83 11	83 15	83 18	83 20	27
34	81 41	81 57	82 12	82 26	82 38	82 49	82 58	83 5	83 11	83 15	83 18	83 20	26
35	81 41	81 58	82 13	82 26	82 38	82 49	82 58	83 5	83 11	83 16	83 18	83 20	25
36	81 41	81 58	82 13	82 26	82 38	82 49	82 58	83 5	83 11	83 16	83 19	83 20	24
37	81 42	81 58	82 13	82 27	82 39	82 49	82 58	83 5	83 11	83 16	83 19	83 20	23
38	81 42	81 58	82 13	82 27	82 39	82 49	82 58	83 5	83 11	83 16	83 19	83 20	22
39	81 42	81 59	82 14	82 27	82 39	82 49	82 58	83 6	83 11	83 16	83 19	83 20	21
40	81 43	81 59	82 14	82 27	82 39	82 49	82 58	83 6	83 12	83 16	83 19	83 20	20
41	81 43	81 59	82 14	82 27	82 39	82 50	82 58	83 6	83 12	83 16	83 19	83 20	19
42	81 43	81 59	82 14	82 28	82 39	82 50	82 59	83 6	83 12	83 16	83 19	83 20	18
43	81 43	82 0	82 15	82 28	82 40	82 50	82 59	83 6	83 12	83 16	83 19	83 20	17
44	81 44	82 0	82 15	82 28	82 40	82 50	82 59	83 6	83 12	83 16	83 19	83 20	16
45	81 44	82 0	82 15	82 28	82 40	82 50	82 59	83 6	83 12	83 16	83 19	83 20	15
46	81 44	82 0	82 15	82 28	82 40	82 50	82 59	83 6	83 12	83 16	83 19	83 20	14
47	81 44	82 1	82 15	82 29	82 40	82 51	82 59	83 6	83 12	83 16	83 19	83 20	13
48	81 45	82 1	82 16	82 29	82 41	82 51	82 59	83 7	83 12	83 16	83 19	83 20	12
49	81 45	82 1	82 16	82 29	82 41	82 51	83 0	83 7	83 12	83 16	83 19	83 20	11
50	81 45	82 1	82 16	82 29	82 41	82 51	83 0	83 7	83 12	83 16	83 19	83 20	10
51	81 46	82 2	82 16	82 30	82 41	82 51	83 0	83 7	83 12	83 16	83 19	83 20	9
52	81 46	82 2	82 17	82 30	82 41	82 51	83 0	83 7	83 13	83 17	83 19	83 20	8
53	81 46	82 2	82 17	82 30	82 41	82 52	83 0	83 7	83 13	83 17	83 19	83 20	7
54	81 46	82 3	82 17	82 30	82 42	82 52	83 0	83 7	83 13	83 17	83 19	83 20	6
55	81 47	82 3	82 17	82 30	82 42	82 52	83 0	83 7	83 13	83 17	83 19	83 20	5
56	81 47	82 3	82 18	82 31	82 42	82 52	83 0	83 7	83 13	83 17	83 19	83 20	4
57	81 47	82 3	82 18	82 31	82 42	82 52	83 1	83 8	83 13	83 17	83 19	83 20	3
58	81 48	82 4	82 18	82 31	82 42	82 52	83 1	83 8	83 13	83 17	83 19	83 20	2
59	81 48	82 4	82 18	82 31	82 43	82 52	83 1	83 8	83 13	83 17	83 19	83 20	1
60	81 48	82 4	82 18	82 31	82 43	82 53	83 1	83 8	83 13	83 17	83 19	83 20	0
	11°	10°	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	M.

Half-Cosines.

TABLE XVIII.

Logarithms of the Meridian Distance.

M.	0 Hour. 0″	5″	10″	15″	20″	25″	30″	35″	40″	45″	50″	55″	M.
0		2.5192	3.1213	3.4734	3.7233	3.9171	4.0755	4.2094	4.3254	4.4277	4.5192	4.6020	0
1	4.6776	4.7471	4.8115	4.8714	4.9274	4.9801	5.0298	5.0767	5.1213	5.1636	5.2041	5.2427	1
2	5.2796	5.3161	5.3492	5.3819	5.4135	5.4440	5.4634	5.5019	5.5295	5.5562	5.5822	5.6073	2
3	5.6318	5.6556	5.6788	5.7013	5.7233	5.7448	5.7657	5.7861	5.8061	5.8256	5.8447	5.8634	3
4	5.8817	5.8996	5.9171	5.9343	5.9512	5.9677	5.9840	5.9999	6.0156	6.0309	6.0460	6.0609	4
5	6.0755	6.0898	6.1040	6.1179	6.1315	6.1450	6.1583	6.1713	6.1842	6.1969	6.2094	6.2217	5
6	6.2338	6.2458	6.2576	6.2693	6.2808	6.2922	6.3034	6.3144	6.3254	6.3361	6.3468	6.3573	6
7	6.3677	6.3780	6.3882	6.3982	6.4081	6.4179	6.4277	6.4373	6.4467	6.4561	6.4654	6 4746	7
8	6.4837	6.4927	6.5016	6.5104	6.5192	6.5278	6.5364	6.5448	6.5532	6.5615	6.5698	6.5779	8
9	6.5860	6.5940	6.6019	6.6098	6.6176	6.6253	6.6330	6.6405	6.6481	6.6555	6.6629	6.6702	9
10	6.6775	6.6847	6.6919	6.6989	6.7060	6.7130	6.7199	6.7267	6.7335	6.7403	6.7470	6.7537	10
11	7603	7668	7733	7798	7862	7926	7989	8051	8114	8176	8237	8298	11
12	8358	8418	8478	8537	8596	8655	8713	8771	8828	8885	8941	8998	12
13	9053	9109	9164	9219	9273	9327	9381	9435	9488	9540	9593	9645	13
14	9697	9748	9800	9851	9901	9952	7.0002	7.0051	7.0101	7.0150	7.0199	7.0248	14
15	7.0296	7.0344	7.0392	7.0439	7.0487	7.0534	0581	0627	0674	0720	0765	0811	15
16	0856	0901	0946	0991	1035	1080	1124	1167	1211	1254	1297	1340	16
17	1383	1425	1467	1509	1551	1593	1634	1676	1717	1757	1798	1839	17
18	1879	1919	1959	1999	2038	2078	2117	2156	2195	2233	2272	2310	18
19	2348	2386	2424	2462	2499	2537	2574	2611	2648	2684	2721	2757	19
20	7.2794	7.2830	7.2866	7.2901	7.2937	7.2973	7.3008	7.3043	7.3078	7.3113	7.3148	7.3183	20
21	3217	3251	3286	3320	3354	3388	3421	3455	3488	3522	3555	3588	21
22	3621	3654	3686	3719	3751	3784	3816	3848	3880	3912	3943	3975	22
23	4007	4038	4069	4100	4131	4162	4193	4224	4255	4285	4315	4346	23
24	4376	4406	4436	4466	4496	4525	4555	4584	4614	4643	4672	4701	24
25	4730	4759	4788	4817	4845	4874	4902	4930	4959	4987	5015	5043	25
26	5071	5098	5126	5154	5181	5208	5236	5263	5290	5117	5144	5171	26
27	5398	5425	5451	5478	5504	5531	5557	5583	5610	5636	5662	5688	27
28	5713	5739	5765	5791	5816	5842	5867	5892	5918	5943	5968	5993	28
29	6018	6043	6068	6092	6117	6142	6166	6191	6215	6239	6264	6288	29
30	7.6312	7.6336	7.6360	7.6384	7.6408	7.6432	7.6455	7.6479	7.6503	7.6526	7.6550	7.6573	30
31	6596	6620	6643	6666	6689	6712	6735	6758	6781	6804	6826	6849	31
32	6872	6894	6917	6939	6962	6984	7006	7028	7050	7073	7095	7117	32
33	7138	7160	7182	7204	7226	7247	7269	7290	7312	7333	7355	7376	33
34	7397	7419	7440	7461	7482	7503	7524	7545	7566	7586	7607	7628	34
35	7649	7669	7690	7710	7731	7751	7772	7792	7812	7832	7853	7873	35
36	7893	7913	7933	7953	7973	7993	8012	8032	8052	8072	8091	8111	36
37	8130	8150	8169	8188	8208	8227	8247	8266	8285	8304	8323	8342	37
38	8361	8380	8399	8418	8437	8456	8475	8493	8512	8531	8549	8568	38
39	8587	8605	8623	8642	8660	8679	8697	8715	8733	8752	8770	8788	39
40	7.8806	7.8824	7.8842	7.8860	7.8878	7.8896	7.8913	7.8931	7.8949	7.8967	7.8985	7.9002	40
41	9020	9037	9055	9072	9090	9107	9125	9142	9160	9177	9194	9211	41
42	9229	9246	9263	9280	9297	9314	9331	9348	9365	9382	9399	9416	42
43	9432	9449	9466	9483	9499	9516	9532	9549	9566	9582	9599	9615	43
44	9631	9648	9664	9680	9697	9713	9729	9745	9762	9778	9794	9810	44
45	9826	9842	9858	9874	9890	9906	9922	9937	9953	9969	9985	8.0001	45
46	8.0016	8.0032	8.0048	8.0063	8.0079	8.0094	8.0110	8.0125	8.0141	8.0156	8.0172	0187	46
47	0202	0218	0233	0248	0264	0279	0294	0309	0324	0339	0355	0370	47
48	0385	0400	0415	0430	0445	0459	0474	0489	0504	0519	0534	0548	48
49	0563	0578	0592	0607	0622	0636	0651	0665	0680	0694	0709	0723	49
50	8.0738	8.0752	8.0767	8.0781	8.0795	8.0810	8.0824	8.0838	8.0852	8.0867	8.0881	8.0895	50
51	0909	0923	0937	0951	0966	0980	0994	1008	1022	1035	1049	1063	51
52	1077	1091	1105	1119	1132	1146	1160	1174	1187	1201	1215	1228	52
53	1242	1255	1269	1283	1296	1310	1323	1337	1350	1363	1377	1390	53
54	1403	1417	1430	1443	1457	1470	1483	1496	1510	1523	1536	1549	54
55	1562	1575	1588	1601	1614	1627	1640	1653	1666	1679	1692	1706	55
56	1718	1731	1744	1756	1769	1782	1795	1807	1820	1833	1845	1858	56
57	1871	1883	1896	1909	1921	1934	1946	1959	1971	1984	1996	2009	57
58	2021	2033	2046	2058	2071	2083	2095	2108	2120	2132	2144	2157	58
59	2169	2181	2193	2205	2217	2230	2242	2254	2266	2278	2290	2302	59

TABLE XVIII.

Logarithms of the Meridian Distance.

M.	1 Hour.												M.
	0″	5″	10″	15″	20″	25″	30″	35″	40″	45″	50″	55″	
0	8.2314	8.2326	8.2338	8.2350	8.2362	8.2374	8.2386	8.2397	8.2409	8.2421	8.2433	8.2445	0
1	2457	2468	2480	2492	2504	2515	2527	2539	2550	2562	2574	2585	1
2	2597	2609	2620	2632	2643	2655	2666	2678	2689	2701	2712	2724	2
3	2735	2747	2758	2769	2781	2792	2803	2815	2826	2837	2849	2860	3
4	2871	2882	2893	2905	2916	2927	2938	2949	2960	2972	2983	2994	4
5	3005	3016	3027	3038	3049	3060	3071	3082	3093	3104	3115	3126	5
6	3137	3147	3158	3169	3180	3191	3202	3212	3223	3234	3245	3256	6
7	3266	3277	3288	3298	3309	3320	3330	3341	3352	3362	3373	3383	7
8	3394	3405	3415	3426	3436	3447	3457	3468	3478	3489	3499	3509	8
9	3520	3530	3541	3551	3561	3572	3582	3592	3603	3613	3623	3634	9
10	8.3644	8.3654	8.3664	8.3675	8.3685	8.3695	8.3705	8.3715	8.3726	8.3736	8.3746	8.3756	10
11	3766	3776	3786	3796	3806	3817	3827	3837	3847	3857	3867	3877	11
12	3887	3897	3907	3916	3926	3936	3946	3956	3966	3976	3986	3996	12
13	4005	4015	4025	4035	4045	4054	4064	4074	4084	4093	4103	4113	13
14	4123	4132	4142	4152	4161	4171	4181	4190	4200	4209	4219	4229	14
15	4238	4248	4257	4267	4276	4286	4295	4305	4314	4324	4333	4343	15
16	4352	4362	4371	4380	4390	4399	4409	4418	4427	4437	4446	4455	16
17	4465	4474	4483	4493	4502	4511	4520	4530	4539	4548	4557	4566	17
18	4576	4585	4594	4603	4612	4621	4631	4640	4649	4658	4667	4676	18
19	4685	4694	4703	4712	4721	4730	4739	4748	4757	4766	4775	4784	19
20	8.4793	8.4802	8.4811	8.4820	8.4829	8.4838	8.4847	8.4856	8.4865	8.4874	8.4882	8.4891	20
21	4900	4909	4918	4927	4935	4944	4953	4962	4971	4979	4988	4997	21
22	5006	5014	5023	5032	5040	5049	5058	5066	5075	5084	5092	5101	22
23	5110	5118	5127	5136	5144	5153	5161	5170	5178	5187	5196	5204	23
24	5213	5221	5230	5238	5247	5255	5264	5272	5281	5289	5297	5306	24
25	5314	5323	5331	5339	5348	5356	5365	5373	5381	5390	5398	5406	25
26	5415	5423	5431	5440	5448	5456	5464	5473	5481	5489	5497	5506	26
27	5514	5522	5530	5538	5547	5555	5563	5571	5579	5588	5596	5604	27
28	5612	5620	5628	5636	5644	5652	5661	5669	5677	5685	5693	5701	28
29	5709	5717	5725	5733	5741	5749	5757	5765	5773	5781	5789	5797	29
30	8.5805	8.5813	8.5821	8.5828	8.5836	8.5844	8.5852	8.5860	8.5868	8.5876	8.5884	8.5892	30
31	5899	5907	5915	5923	5931	5939	5946	5954	5962	5970	5978	5985	31
32	5993	6001	6009	6016	6024	6032	6039	6047	6055	6063	6070	6078	32
33	6086	6093	6101	6109	6116	6124	6132	6139	6147	6154	6162	6170	33
34	6177	6185	6192	6200	6208	6215	6223	6230	6238	6245	6253	6260	34
35	6268	6275	6283	6290	6298	6305	6313	6320	6328	6335	6343	6350	35
36	6358	6365	6372	6380	6387	6395	6402	6409	6417	6424	6432	6439	36
37	6446	6454	6461	6468	6476	6483	6490	6497	6505	6512	6519	6527	37
38	6534	6541	6548	6556	6563	6570	6577	6585	6592	6599	6606	6614	38
39	6621	6628	6635	6642	6650	6657	6664	6671	6678	6685	6692	6700	39
40	8.6707	8.6714	8.6721	8.6728	8.6735	8.6742	8.6749	8.6756	8.6764	8.6771	8.6778	8.6785	40
41	6792	6799	6806	6813	6820	6827	6834	6841	6848	6855	6862	6869	41
42	6876	6883	6890	6897	6904	6911	6918	6925	6932	6938	6945	6952	42
43	6959	6966	6973	6980	6987	6994	7001	7007	7014	7021	7028	7035	43
44	7042	7049	7055	7062	7069	7076	7083	7089	7096	7103	7110	7117	44
45	7123	7130	7137	7144	7150	7157	7164	7171	7177	7184	7191	7198	45
46	7204	7211	7218	7224	7231	7238	7244	7251	7258	7264	7271	7278	46
47	7284	7291	7298	7304	7311	7317	7324	7331	7337	7344	7350	7357	47
48	7364	7370	7377	7383	7390	7396	7403	7410	7416	7423	7429	7436	48
49	7442	7449	7455	7462	7468	7475	7481	7488	7494	7501	7507	7514	49
50	8.7520	8.7526	8.7533	8.7539	8.7546	8.7552	8.7559	8.7565	8.7571	8.7578	8.7584	8.7591	50
51	7597	7603	7610	7616	7623	7629	7635	7642	7648	7654	7661	7667	51
52	7673	7680	7686	7692	7699	7705	7711	7718	7724	7730	7737	7743	52
53	7749	7755	7762	7768	7774	7780	7787	7793	7799	7805	7812	7818	53
54	7824	7830	7836	7843	7849	7855	7861	7867	7874	7880	7886	7892	54
55	7898	7904	7911	7917	7923	7929	7935	7941	7947	7954	7960	7966	55
56	7972	7978	7984	7990	7996	8002	8008	8015	8021	8027	8033	8039	56
57	8045	8051	8057	8063	8069	8075	8081	8087	8093	8099	8105	8111	57
58	8117	8123	8129	8135	8141	8147	8153	8159	8165	8171	8177	8183	58
59	8189	8195	8201	8207	8213	8219	8224	8230	8236	8242	8248	8254	59

TABLE XVIII.

Logarithms of the Meridian Distance.

M.	2 Hours. 0″	5″	10″	15″	20″	25″	30″	35″	40″	45″	50″	55″	M.
0	8.8260	8.8266	8.8272	8.8278	8.8283	8.8289	8.8295	8.8301	8.8307	8.8313	8.8319	8.8324	0
1	8330	8336	8342	8348	8354	8359	8365	8371	8377	8383	8388	8394	1
2	8400	8406	8412	8417	8423	8429	8435	8441	8446	8452	8458	8464	2
3	8469	8475	8481	8487	8492	8498	8504	8509	8515	8521	8527	8532	3
4	8538	8544	8549	8555	8561	8566	8572	8578	8583	8589	8595	8600	4
5	8606	8612	8617	8623	8629	8634	8640	8645	8651	8657	8662	8668	5
6	8673	8679	8685	8690	8696	8701	8707	8713	8718	8724	8729	8735	6
7	8740	8746	8751	8757	8763	8768	8774	8779	8785	8790	8796	8801	7
8	8807	8812	8818	8823	8829	8834	8840	8845	8851	8856	8862	8867	8
9	8873	8878	8883	8889	8894	8900	8905	8911	8916	8922	8927	8932	9
10	8.8938	8.8943	8.8949	8.8954	8.8959	8.8965	8.8970	8.8976	8.8981	8.8986	8.8992	8.8997	10
11	9003	9008	9013	9019	9024	9029	9035	9040	9045	9051	9056	9061	11
12	9067	9072	9077	9083	9088	9093	9099	9104	9109	9115	9120	9125	12
13	9131	9136	9141	9146	9152	9157	9162	9167	9173	9178	9183	9188	13
14	9194	9199	9204	9209	9215	9220	9225	9230	9236	9241	9246	9251	14
15	9256	9262	9267	9272	9277	9282	9288	9293	9298	9303	9308	9313	15
16	9319	9324	9329	9334	9339	9344	9350	9355	9360	9365	9370	9375	16
17	9380	9386	9391	9396	9401	9406	9411	9416	9421	9426	9431	9437	17
18	9442	9447	9452	9457	9462	9467	9472	9477	9482	9487	9492	9497	18
19	9502	9507	9513	9518	9523	9528	9533	9538	9543	9548	9553	9558	19
20	8.9563	8.9568	8.9573	8.9578	8.9583	8.9588	8.9593	8.9598	8.9603	8.9608	8.9613	8.9618	20
21	9623	9628	9633	9638	9643	9647	9652	9657	9662	9667	9672	9677	21
22	9682	9687	9692	9697	9702	9707	9712	9717	9721	9726	9731	9736	22
23	9741	9746	9751	9756	9761	9766	9770	9775	9780	9785	9790	9795	23
24	9800	9804	9809	9814	9819	9824	9829	9834	9838	9843	9848	9853	24
25	9858	9863	9867	9872	9877	9882	9887	9891	9896	9901	9906	9911	25
26	9915	9920	9925	9930	9935	9939	9944	9949	9954	9958	9963	9968	26
27	9973	9977	9982	9987	9992	9996	9.0001	9.0006	9.0011	9.0015	9.0020	9.0025	27
28	9.0029	9.0034	9.0039	9.0044	9.0048	9.0053	0058	0062	0067	0072	0077	0081	28
29	0086	0091	0095	0100	0105	0109	0114	0119	0123	0128	0133	0137	29
30	9.0142	9.0147	9.0151	9.0156	9.0161	9.0165	9.0170	9.0174	9.0179	9.0184	9.0188	9.0193	30
31	0198	0202	0207	0211	0216	0221	0225	0230	0234	0239	0244	0248	31
32	0253	0257	0262	0267	0271	0276	0280	0285	0289	0294	0299	0303	32
33	0308	0312	0317	0321	0326	0330	0335	0339	0344	0349	0353	0358	33
34	0362	0367	0371	0376	0380	0385	0389	0394	0398	0403	0407	0412	34
35	0416	0421	0425	0430	0434	0439	0443	0448	0452	0456	0461	0465	35
36	0470	0474	0479	0483	0488	0492	0497	0501	0505	0510	0514	0519	36
37	0523	0528	0532	0536	0541	0545	0550	0554	0559	0563	0567	0572	37
38	0576	0581	0585	0589	0594	0598	0602	0607	0611	0616	0620	0624	38
39	0629	0633	0637	0642	0646	0651	0655	0659	0664	0668	0672	0677	39
40	9.0681	9.0685	9.0690	9.0694	9.0698	9.0703	9.0707	9.0711	9.0716	9.0720	9.0724	9.0729	40
41	0733	0737	0741	0746	0750	0754	0759	0763	0767	0772	0776	0780	41
42	0784	0789	0793	0797	0802	0806	0810	0814	0819	0823	0827	0831	42
43	0836	0840	0844	0848	0853	0857	0861	0865	0870	0874	0878	0882	43
44	0886	0891	0895	0899	0903	0908	0912	0916	0920	0924	0929	0933	44
45	0937	0941	0945	0950	0954	0958	0962	0966	0970	0975	0979	0983	45
46	0987	0991	0995	1000	1004	1008	1012	1016	1020	1025	1029	1033	46
47	1037	1041	1045	1049	1054	1058	1062	1066	1070	1074	1078	1082	47
48	1087	1091	1095	1099	1103	1107	1111	1115	1119	1123	1128	1132	48
49	1136	1140	1144	1148	1152	1156	1160	1164	1168	1172	1176	1181	49
50	9.1185	9.1189	9.1193	9.1197	9.1201	9.1205	9.1209	9.1213	9.1217	9.1221	9.1225	9.1229	50
51	1233	1237	1241	1245	1249	1253	1257	1261	1265	1269	1273	1277	51
52	1281	1285	1289	1293	1297	1301	1305	1309	1313	1317	1321	1325	52
53	1329	1333	1337	1341	1345	1349	1353	1357	1361	1365	1369	1373	53
54	1377	1381	1385	1389	1393	1397	1401	1405	1409	1413	1417	1420	54
55	1424	1428	1432	1436	1440	1444	1448	1452	1456	1460	1464	1468	55
56	1471	1475	1479	1483	1487	1491	1495	1499	1503	1507	1510	1514	56
57	1518	1522	1526	1530	1534	1538	1541	1545	1549	1553	1557	1561	57
58	1565	1569	1572	1576	1580	1584	1588	1592	1595	1599	1603	1607	58
59	1611	1615	1619	1622	1626	1630	1634	1638	1641	1645	1649	1653	59

TABLE XVIII.

Logarithms of the Meridian Distance.

3 Hours.

M.	0″	5″	10″	15″	20″	25″	30″	35″	40″	45″	50″	55″	M.
0	9.1657	9.1661	9.1664	9.1668	9.1672	9.1676	9.1680	9.1683	9.1687	9.1691	9.1695	9.1699	0
1	1702	1706	1710	1714	1717	1721	1725	1729	1733	1736	1740	1744	1
2	1748	1751	1755	1759	1763	1766	1770	1774	1778	1781	1785	1789	2
3	1793	1796	1800	1804	1808	1811	1815	1819	1823	1826	1830	1834	3
4	1838	1841	1845	1849	1852	1856	1860	1864	1867	1871	1875	1878	4
5	1882	1886	1889	1893	1897	1900	1904	1908	1912	1915	1919	1923	5
6	1926	1930	1934	1937	1941	1945	1948	1952	1956	1959	1963	1967	6
7	1970	1974	1978	1981	1985	1988	1992	1996	1999	2003	2007	2010	7
8	2014	2018	2021	2025	2028	2032	2036	2039	2043	2047	2050	2054	8
9	2057	2061	2065	2068	2072	2075	2079	2083	2086	2090	2093	2097	9
10	9.2101	9.2104	9.2108	9.2111	9.2115	9.2119	9.2122	9.2126	9.2129	9.2133	9.2136	9.2140	10
11	2144	2147	2151	2154	2158	2161	2165	2168	2172	2176	2179	2183	11
12	2186	2190	2193	2197	2200	2204	2207	2211	2215	2218	2222	2225	12
13	2229	2232	2236	2239	2243	2246	2250	2253	2257	2260	2264	2267	13
14	2271	2274	2278	2281	2285	2288	2292	2295	2299	2302	2306	2309	14
15	2313	2316	2320	2323	2327	2330	2334	2337	2341	2344	2348	2351	15
16	2354	2358	2361	2365	2368	2372	2375	2379	2382	2386	2389	2393	16
17	2396	2399	2403	2406	2410	2413	2417	2420	2423	2427	2430	2434	17
18	2437	2441	2444	2447	2451	2454	2458	2461	2465	2468	2471	2475	18
19	2478	2482	2485	2488	2492	2495	2499	2502	2505	2509	2512	2516	19
20	9.2519	9.2522	9.2526	9.2529	9.2532	9.2536	9.2539	9.2543	9.2546	9.2549	9.2553	9.2556	20
21	2559	2563	2566	2570	2573	2576	2580	2583	2586	2590	2593	2596	21
22	2600	2603	2606	2610	2613	2616	2620	2623	2626	2630	2633	2636	22
23	2640	2643	2646	2650	2653	2656	2660	2663	2666	2670	2673	2676	23
24	2680	2683	2686	2690	2693	2696	2699	2703	2706	2709	2713	2716	24
25	2719	2723	2726	2729	2732	2736	2739	2742	2746	2749	2752	2755	25
26	2759	2762	2765	2768	2772	2775	2778	2782	2785	2788	2791	2795	26
27	2798	2801	2804	2808	2811	2814	2817	2821	2824	2827	2830	2834	27
28	2837	2840	2843	2846	2850	2853	2856	2859	2863	2866	2869	2872	28
29	2876	2879	2882	2885	2888	2892	2895	2898	2901	2904	2908	2911	29
30	9.2914	9.2917	9.2920	9.2924	9.2927	9.2930	9.2933	9.2936	9.2940	9.2943	9.2946	9.2949	30
31	2952	2956	2959	2962	2965	2968	2971	2975	2978	2981	2984	2987	31
32	2990	2994	2997	3000	3003	3006	3009	3013	3016	3019	3022	3025	32
33	3028	3032	3035	3038	3041	3044	3047	3050	3054	3057	3060	3063	33
34	3066	3069	3072	3075	3079	3082	3085	3088	3091	3094	3097	3100	34
35	3104	3107	3110	3113	3116	3119	3122	3125	3128	3132	3135	3138	35
36	3141	3144	3147	3150	3153	3156	3159	3163	3166	3169	3172	3175	36
37	3178	3181	3184	3187	3190	3193	3196	3200	3203	3206	3209	3212	37
38	3215	3218	3221	3224	3227	3230	3233	3236	3239	3242	3245	3249	38
39	3252	3255	3258	3261	3264	3267	3270	3273	3276	3279	3282	3285	39
40	9.3288	9.3291	9.3294	9.3297	9.3300	9.3303	9.3306	9.3309	9.3312	9.3315	9.3318	9.3321	40
41	3324	3327	3330	3333	3336	3339	3342	3345	3348	3351	3354	3357	41
42	3360	3363	3366	3369	3372	3375	3378	3381	3384	3387	3390	3393	42
43	3396	3399	3402	3405	3408	3411	3414	3417	3420	3423	3426	3429	43
44	3432	3435	3438	3441	3444	3447	3450	3453	3456	3459	3462	3465	44
45	3468	3471	3474	3477	3479	3482	3485	3488	3491	3494	3497	3500	45
46	3503	3506	3509	3512	3515	3518	3521	3524	3527	3529	3532	3535	46
47	3538	3541	3544	3547	3550	3553	3556	3559	3562	3564	3567	3570	47
48	3573	3576	3579	3582	3585	3588	3591	3594	3596	3599	3602	3605	48
49	3608	3611	3614	3617	3620	3622	3625	3628	3631	3634	3637	3640	49
50	9.3643	9.3646	9.3648	9.3651	9.3654	9.3657	9.3660	9.3663	9.3666	9.3669	9.3671	9.3674	50
51	3677	3680	3683	3686	3689	3691	3694	3697	3700	3703	3706	3709	51
52	3711	3714	3717	3720	3723	3726	3728	3731	3734	3737	3740	3743	52
53	3745	3748	3751	3754	3757	3760	3762	3765	3768	3771	3774	3777	53
54	3779	3782	3785	3788	3791	3793	3796	3799	3802	3805	3808	3810	54
55	3813	3816	3819	3822	3824	3827	3830	3833	3836	3838	3841	3844	55
56	3847	3850	3852	3855	3858	3861	3863	3866	3869	3872	3875	3877	56
57	3880	3883	3886	3888	3891	3894	3897	3900	3902	3905	3908	3911	57
58	3913	3916	3919	3922	3924	3927	3930	3933	3935	3938	3941	3944	58
59	3946	3949	3952	3955	3957	3960	3963	3966	3968	3971	3974	3977	59

TABLE XVIII.

Logarithms of the Meridian Distance.

M.	4 Hours. 0″	5″	10″	15″	20″	25″	30″	35″	40″	45″	50″	55″	M.
0	9.3979	9.3982	9.3985	9.3988	9.3990	9.3993	9.3996	9.3998	9.4001	9.4004	9.4007	9.4009	0
1	4012	4015	4018	4020	4023	4026	4028	4031	4034	4037	4039	4042	1
2	4045	4047	4050	4053	4055	4058	4061	4064	4066	4069	4072	4074	2
3	4077	4080	4082	4085	4088	4091	4093	4096	4099	4101	4104	4107	3
4	4109	4112	4115	4117	4120	4123	4125	4128	4131	4133	4136	4139	4
5	4141	4144	4147	4149	4152	4155	4157	4160	4163	4165	4168	4171	5
6	4173	4176	4179	4181	4184	4187	4189	4192	4195	4197	4200	4202	6
7	4205	4208	4210	4213	4216	4218	4221	4224	4226	4229	4231	4234	7
8	4237	4239	4242	4245	4247	4250	4252	4255	4258	4260	4263	4266	8
9	4268	4271	4273	4276	4279	4281	4284	4286	4289	4292	4294	4297	9
10	9.4300	9.4302	9.4305	9.4307	9.4310	9.4312	9.4315	9.4318	9.4320	9.4323	9.4325	9.4328	10
11	4331	4333	4336	4338	4341	4344	4346	4349	4351	4354	4356	4359	11
12	4362	4364	4367	4369	4372	4375	4377	4380	4382	4385	4387	4390	12
13	4392	4395	4398	4400	4403	4405	4408	4410	4413	4416	4418	4421	13
14	4423	4426	4428	4431	4433	4436	4438	4441	4443	4446	4449	4451	14
15	4454	4456	4459	4461	4464	4466	4469	4471	4474	4477	4479	4482	15
16	4484	4487	4489	4492	4494	4497	4499	4502	4504	4507	4509	4512	16
17	4514	4517	4519	4522	4524	4527	4529	4532	4534	4537	4539	4542	17
18	4545	4547	4550	4552	4555	4557	4559	4562	4564	4567	4569	4572	18
19	4574	4577	4580	4582	4584	4587	4589	4592	4594	4597	4599	4602	19
20	9.4604	9.4607	9.4609	9.4612	9.4614	9.4617	9.4619	9.4622	9.4624	9.4627	9.4629	9.4631	20
21	4634	4636	4639	4641	4644	4646	4649	4651	4654	4656	4659	4661	21
22	4663	4666	4668	4671	4673	4676	4678	4681	4683	4686	4688	4690	22
23	4693	4695	4698	4700	4703	4705	4708	4710	4712	4715	4717	4720	23
24	4722	4725	4727	4729	4732	4734	4737	4739	4742	4744	4746	4749	24
25	4751	4754	4756	4758	4761	4763	4766	4768	4771	4773	4775	4778	25
26	4780	4783	4785	4787	4790	4792	4795	4797	4799	4802	4804	4807	26
27	4809	4811	4814	4816	4819	4821	4823	4826	4828	4831	4833	4835	27
28	4838	4840	4843	4845	4847	4850	4852	4854	4857	4859	4862	4864	28
29	4866	4869	4871	4873	4876	4878	4881	4883	4885	4888	4890	4892	29
30	9.4895	9.4897	9.4899	9.4902	9.4904	9.4907	9.4909	9.4911	9.4914	9.4916	9.4918	9.4921	30
31	4923	4925	4928	4930	4932	4935	4937	4939	4942	4944	4946	4949	31
32	4951	4954	4956	4958	4961	4963	4965	4968	4970	4972	4975	4977	32
33	4979	4982	4984	4986	4989	4991	4993	4996	4998	5000	5002	5005	33
34	5007	5009	5012	5014	5016	5019	5021	5023	5026	5028	5030	5033	34
35	5035	5037	5039	5042	5044	5046	5049	5051	5053	5056	5058	5060	35
36	5063	5065	5067	5069	5072	5074	5076	5079	5081	5083	5085	5088	36
37	5090	5092	5095	5097	5099	5101	5104	5106	5108	5111	5113	5115	37
38	5117	5120	5122	5124	5126	5129	5131	5133	5136	5138	5140	5142	38
39	5145	5147	5149	5151	5154	5156	5158	5160	5163	5165	5167	5170	39
40	9.5172	9.5174	9.5176	9.5179	9.5181	9.5183	9.5185	9.5188	9.5190	9.5192	9.5194	9.5197	40
41	5199	5201	5203	5206	5208	5210	5212	5214	5217	5219	5221	5223	41
42	5226	5228	5230	5232	5235	5237	5239	5241	5243	5246	5248	5250	42
43	5252	5255	5257	5259	5261	5264	5266	5268	5270	5272	5275	5277	43
44	5279	5281	5283	5286	5288	5290	5292	5295	5297	5299	5301	5303	44
45	5306	5308	5310	5312	5314	5317	5319	5321	5323	5325	5328	5330	45
46	5332	5334	5336	5338	5341	5343	5345	5347	5349	5352	5354	5356	46
47	5358	5360	5363	5365	5367	5369	5371	5373	5376	5378	5380	5382	47
48	5384	5386	5389	5391	5393	5395	5397	5400	5402	5404	5406	5408	48
49	5410	5413	5415	5417	5419	5421	5423	5425	5428	5430	5432	5434	49
50	9.5436	9.5438	9.5441	9.5443	9.5445	9.5447	9.5449	9.5451	9.5453	9.5456	9.5458	9.5460	50
51	5462	5464	5466	5468	5471	5473	5475	5477	5479	5481	5483	5486	51
52	5488	5490	5492	5494	5496	5498	5500	5503	5505	5507	5509	5511	52
53	5513	5515	5517	5520	5522	5524	5526	5528	5530	5532	5534	5537	53
54	5539	5541	5543	5545	5547	5549	5551	5553	5556	5558	5560	5562	54
55	5564	5566	5568	5570	5572	5575	5577	5579	5581	5583	5585	5587	55
56	5589	5591	5593	5595	5598	5600	5602	5604	5606	5608	5610	5612	56
57	5614	5616	5618	5621	5623	5625	5627	5629	5631	5633	5635	5637	57
58	5639	5641	5643	5646	5648	5650	5652	5654	5656	5658	5660	5662	58
59	5664	5666	5668	5670	5672	5674	5677	5679	5681	5683	5685	5687	59

TABLE XVIII.

Logarithms of the Meridian Distance.

M.	5 Hours. 0″	5″	10″	15″	20″	25″	30″	35″	40″	45″	50″	55″	M.
0	9.5689	9.5691	9.5693	9.5695	9.5697	9.5699	9.5701	9.5703	9.5705	9.5707	9.5709	9.5711	0
1	5714	5716	5718	5720	5722	5724	5726	5728	5730	5732	5734	5736	1
2	5738	5740	5742	5744	5746	5748	5750	5752	5754	5756	5758	5760	2
3	5762	5765	5767	5769	5771	5773	5775	5777	5779	5781	5783	5785	3
4	5787	5789	5791	5793	5795	5797	5799	5801	5803	5805	5807	5809	4
5	5811	5813	5815	5817	5819	5821	5823	5825	5827	5829	5831	5833	5
6	5835	5837	5839	5841	5843	5845	5847	5849	5851	5853	5855	5857	6
7	5859	5861	5863	5865	5867	5869	5871	5873	5875	5877	5879	5881	7
8	5883	5885	5887	5889	5891	5893	5895	5897	5899	5901	5903	5905	8
9	5907	5909	5911	5913	5915	5917	5919	5921	5922	5924	5926	5928	9
10	9.5930	9.5932	9.5934	9.5936	9.5938	9.5940	9.5942	9.5944	9.5946	9.5948	9.5950	9.5952	10
11	5954	5956	5958	5960	5962	5964	5966	5968	5970	5972	5973	5975	11
12	5977	5979	5981	5983	5985	5987	5989	5991	5993	5995	5997	5999	12
13	6001	6003	6005	6007	6008	6010	6012	6014	6016	6018	6020	6022	13
14	6024	6026	6028	6030	6032	6034	6036	6037	6039	6041	6043	6045	14
15	6047	6049	6051	6053	6055	6057	6059	6061	6062	6064	6066	6068	15
16	6070	6072	6074	6076	6078	6080	6082	6084	6085	6087	6089	6091	16
17	6093	6095	6097	6099	6101	6103	6105	6106	6108	6110	6112	6114	17
18	6116	6118	6120	6122	6124	6125	6127	6129	6131	6133	6135	6137	18
19	6139	6141	6142	6144	6146	6148	6150	6152	6154	6156	6158	6159	19
20	9.6161	9.6163	9.6165	9.6167	9.6169	9.6171	9.6173	9.6174	9.6176	9.6178	9.6180	9.6182	20
21	6184	6186	6188	6189	6191	6193	6195	6197	6199	6201	6203	6204	21
22	6206	6208	6210	6212	6214	6216	6217	6219	6221	6223	6225	6227	22
23	6229	6230	6232	6234	6236	6238	6240	6242	6243	6245	6247	6249	23
24	6251	6253	6255	6256	6258	6260	6262	6264	6266	6267	6269	6271	24
25	6273	6275	6277	6278	6280	6282	6284	6286	6288	6290	6291	6293	25
26	6295	6297	6299	6301	6302	6304	6306	6308	6310	6311	6313	6315	26
27	6317	6319	6321	6322	6324	6326	6328	6330	6332	6333	6335	6337	27
28	6339	6341	6342	6344	6346	6348	6350	6352	6353	6355	6357	6359	28
29	6361	6362	6364	6366	6368	6370	6371	6373	6375	6377	6379	6380	29
30	9.6382	9.6384	9.6386	9.6388	9.6389	9.6391	9.6393	9.6395	9.6397	9.6398	9.6400	9.6402	30
31	6404	6406	6407	6409	6411	6413	6415	6416	6418	6420	6422	6423	31
32	6425	6427	6429	6431	6432	6434	6436	6438	6439	6441	6443	6445	32
33	6447	6448	6450	6452	6454	6455	6457	6459	6461	6463	6464	6466	33
34	6468	6470	6471	6473	6475	6477	6478	6480	6482	6484	6486	6487	34
35	6489	6491	6493	6494	6496	6498	6500	6501	6503	6505	6507	6508	35
36	6510	6512	6514	6515	6517	6519	6521	6522	6524	6526	6528	6529	36
37	6531	6533	6535	6536	6538	6540	6542	6543	6545	6547	6549	6550	37
38	6552	6554	6556	6557	6559	6561	6562	6564	6566	6568	6569	6571	38
39	6573	6575	6576	6578	6580	6582	6583	6585	6587	6588	6590	6592	39
40	9.6594	9.6595	9.6597	9.6599	9.6601	9.6602	9.6604	9.6606	9.6607	9.6609	9.6611	9.6613	40
41	6614	6616	6618	6619	6621	6623	6625	6626	6628	6630	6631	6683	41
42	6635	6637	6638	6640	6642	6643	6645	6647	6648	6649	6652	6654	42
43	6655	6657	6659	6660	6662	6664	6665	6667	6669	6671	6672	6674	43
44	6676	6677	6679	6681	6682	6684	6686	6687	6689	6691	6693	6694	44
45	6696	6698	6699	6701	6703	6704	6706	6708	6709	6711	6713	6714	45
46	6716	6718	6719	6721	6723	6724	6726	6728	6729	6731	6733	6735	46
47	6736	6738	6740	6741	6743	6745	6746	6748	6750	6751	6753	6755	47
48	6756	6758	6760	6761	6763	6765	6766	6768	6769	6771	6773	6774	48
49	6776	6778	6779	6781	6783	6784	6786	6788	6789	6791	6793	6794	49
50	9.6796	9.6798	9.6799	9.6801	9.6803	9.6804	9.6806	9.6807	9.6809	9.6811	9.6812	9.6814	50
51	6816	6817	6819	6821	6822	6824	6826	6827	6829	6830	6832	6834	51
52	6835	6837	6839	6840	6842	6844	6845	6847	6848	6850	6852	6853	52
53	6855	6857	6858	6860	6861	6863	6865	6866	6868	6870	6872	6873	53
54	6874	6876	6878	6879	6881	6883	6884	6886	6887	6889	6891	6892	54
55	6894	6895	6897	6899	6900	6902	6904	6905	6907	6908	6910	6912	55
56	6913	6915	6916	6918	6920	6921	6923	6924	6926	6928	6929	6931	56
57	6932	6934	6936	6937	6939	6940	6942	6944	6945	6947	6948	6950	57
58	6952	6953	6955	6956	6958	6960	6961	6963	6964	6966	6967	6969	58
59	6971	6972	6974	6975	6977	6979	6980	6982	6983	6985	6987	6988	59

TABLE XVIII.

Logarithms of the Meridian Distance.

M.	6 Hours. 0″	5″	10″	15″	20″	25″	30″	35″	40″	45″	50″	55″	M.
0	9.6990	9.6991	9.6993	9.6994	9.6996	9.6998	9.6999	9.7001	9.7002	9.7004	9.7005	9.7007	0
1	7009	7010	7012	7013	7015	7016	7018	7020	7021	7023	7024	7026	1
2	7027	7029	7031	7032	7034	7035	7037	7038	7040	7041	7043	7045	2
3	7046	7048	7049	7051	7052	7054	7055	7057	7059	7060	7062	7063	3
4	7065	7066	7068	7069	7071	7073	7074	7076	7077	7079	7080	7082	4
5	7083	7085	7086	7088	7090	7091	7093	7094	7096	7097	7099	7100	5
6	7102	7103	7105	7106	7108	7110	7111	7113	7114	7116	7117	7119	6
7	7120	7122	7123	7125	7126	7128	7129	7131	7133	7134	7136	7137	7
8	7139	7140	7142	7143	7145	7146	7148	7149	7151	7152	7154	7155	8
9	7157	7158	7160	7161	7163	7164	7166	7168	7169	7171	7172	7174	9
10	9.7175	9.7177	9.7178	9.7180	9.7181	9.7183	9.7184	9.7186	9.7187	9.7189	9.7190	9.7192	10
11	7193	7195	7196	7198	7199	7201	7202	7203	7205	7207	7208	7210	11
12	7211	7213	7214	7216	7217	7219	7220	7222	7223	7225	7226	7228	12
13	7229	7231	7232	7234	7235	7237	7238	7240	7241	7243	7244	7246	13
14	7247	7248	7250	7251	7253	7254	7256	7257	7259	7260	7262	7263	14
15	7265	7266	7268	7269	7271	7272	7274	7275	7277	7278	7280	7281	15
16	7282	7284	7285	7287	7288	7290	7291	7293	7294	7296	7297	7299	16
17	7300	7302	7303	7305	7306	7307	7309	7310	7312	7313	7315	7316	17
18	7318	7319	7321	7322	7324	7325	7326	7328	7329	7331	7332	7334	18
19	7335	7337	7338	7340	7341	7342	7344	7345	7347	7348	7350	7351	19
20	9.7353	9.7354	9.7355	9.7357	9.7358	9.7360	9.7361	9.7363	9.7364	9.7366	9.7367	9.7368	20
21	7370	7371	7373	7374	7376	7377	7379	7380	7381	7383	7384	7386	21
22	7387	7389	7390	7391	7393	7394	7396	7397	7399	7400	7401	7403	22
23	7404	7406	7407	7409	7410	7411	7413	7414	7416	7417	7419	7420	23
24	7421	7423	7424	7426	7427	7429	7430	7431	7433	7434	7436	7437	24
25	7438	7440	7441	7443	7444	7446	7447	7448	7450	7451	7453	7454	25
26	7455	7457	7458	7460	7461	7462	7464	7465	7467	7468	7469	7471	26
27	7472	7474	7475	7476	7478	7479	7481	7482	7483	7485	7486	7488	27
28	7489	7490	7492	7493	7495	7496	7497	7499	7500	7502	7503	7504	28
29	7506	7507	7509	7510	7511	7513	7514	7516	7517	7518	7520	7521	29
30	9.7522	9.7524	9.7525	9.7527	9.7528	9.7529	9.7531	9.7532	9.7534	9.7535	9.7536	9.7538	30
31	7539	7540	7542	7543	7545	7546	7547	7549	7550	7551	7553	7554	31
32	7556	7557	7558	7560	7561	7562	7564	7565	7567	7568	7569	7571	32
33	7572	7573	7575	7576	7577	7579	7580	7582	7583	7584	7586	7587	33
34	7588	7590	7591	7592	7594	7595	7597	7598	7599	7601	7602	7603	34
35	7605	7606	7607	7609	7610	7611	7613	7614	7615	7617	7618	7620	35
36	7621	7622	7624	7625	7626	7628	7629	7630	7632	7633	7634	7636	36
37	7637	7638	7640	7641	7642	7644	7645	7646	7648	7649	7650	7652	37
38	7653	7654	7656	7657	7658	7660	7661	7662	7664	7665	7666	7668	38
39	7669	7670	7672	7673	7674	7676	7677	7678	7680	7681	7682	7684	39
40	9.7685	9.7686	9.7688	9.7689	9.7690	9.7692	9.7693	9.7694	9.7696	9.7697	9.7698	9.7700	40
41	7701	7702	7704	7705	7706	7707	7709	7710	7711	7713	7714	7715	41
42	7717	7718	7719	7721	7722	7723	7725	7726	7727	7728	7730	7731	42
43	7732	7734	7735	7736	7738	7739	7740	7742	7743	7744	7745	7747	43
44	7748	7749	7751	7752	7753	7755	7756	7757	7758	7760	7761	7762	44
45	7764	7765	7766	7768	7769	7770	7771	7773	7774	7775	7777	7778	45
46	7779	7780	7782	7783	7784	7786	7787	7788	7789	7791	7792	7793	46
47	7795	7796	7797	7798	7800	7801	7802	7804	7805	7806	7807	7809	47
48	7810	7811	7813	7814	7815	7816	7818	7819	7820	7821	7823	7824	48
49	7825	7827	7828	7829	7830	7832	7833	7834	7835	7837	7838	7839	49
50	9.7841	9.7842	9.7843	9.7844	9.7846	9.7847	9.7848	9.7849	9.7851	9.7852	9.7853	9.7854	50
51	7856	7857	7858	7860	7861	7862	7863	7865	7866	7867	7868	7870	51
52	7871	7872	7873	7875	7876	7877	7878	7880	7881	7882	7883	7885	52
53	7886	7887	7888	7890	7891	7892	7893	7895	7896	7897	7898	7900	53
54	7901	7902	7903	7905	7906	7907	7908	7910	7911	7912	7913	7915	54
55	7916	7917	7918	7919	7921	7922	7923	7924	7926	7927	7928	7929	55
56	7931	7932	7933	7934	7936	7937	7938	7939	7940	7942	7943	7944	56
57	7945	7947	7948	7949	7950	7951	7953	7954	7955	7956	7958	7959	57
58	7960	7961	7963	7964	7965	7966	7967	7969	7970	7971	7972	7973	58
59	7975	7976	7977	7978	7980	7981	7982	7983	7984	7986	7987	7988	59

TABLE XVIII.

Logarithms of the Meridian Distance.

7 Hours.

M.	0″	5″	10″	15″	20″	25″	30″	35″	40″	45″	50″	55″	M.
0	9.7989	9.7991	9.7992	9.7993	9.7994	9.7995	9.7997	9.7998	9.7999	9.8000	9.8001	9.8003	0
1	8004	8005	8006	8008	8009	8010	8011	8012	8014	8015	8016	8017	1
2	8018	8020	8021	8022	8023	8024	8026	8027	8028	8029	8030	8032	2
3	8033	8034	8035	8036	8037	8039	8040	8041	8042	8043	8045	8046	3
4	8047	8048	8049	8051	8052	8053	8054	8055	8057	8058	8059	8060	4
5	8061	8062	8064	8065	8066	8067	8068	8070	8071	8072	8073	8074	5
6	8075	8077	8078	8079	8080	8081	8083	8084	8085	8086	8087	8088	6
7	8090	8091	8092	8093	8094	8095	8097	8098	8099	8100	8101	8102	7
8	8104	8105	8106	8107	8108	8109	8111	8112	8113	8114	8115	8116	8
9	8118	8119	8120	8121	8122	8123	8125	8126	8127	8128	8129	8130	9
10	9.8132	9.8133	9.8134	9.8135	9.8136	9.8137	9.8138	9.8140	9.8141	9.8142	9.8143	9.8144	10
11	8145	8147	8148	8149	8150	8151	8152	8153	8155	8156	8157	8158	11
12	8159	8160	8161	8163	8164	8165	8166	8167	8168	8170	8171	8172	12
13	8173	8174	8175	8176	8178	8179	8180	8181	8182	8183	8184	8185	13
14	8187	8188	8189	8190	8191	8192	8193	8195	8196	8197	8198	8199	14
15	8200	8201	8202	8204	8205	8206	8207	8208	8209	8210	8212	8213	15
16	8214	8215	8216	8217	8218	8219	8221	8222	8223	8224	8225	8226	16
17	8227	8228	8229	8231	8232	8233	8234	8235	8236	8237	8238	8240	17
18	8241	8242	8243	8244	8245	8246	8247	8248	8250	8251	8252	8253	18
19	8254	8255	8256	8257	8258	8260	8261	8262	8263	8264	8265	8266	19
20	9.8267	9.8268	9.8270	9.8271	9.8272	9.8273	9.8274	9.8275	9.8276	9.8277	9.8278	9.8279	20
21	8281	8282	8283	8284	8285	8286	8287	8288	8289	8290	8292	8293	21
22	8294	8295	8296	8297	8298	8299	8300	8301	8303	8304	8305	8306	22
23	8307	8308	8309	8310	8311	8312	8313	8315	8316	8317	8318	8319	23
24	8320	8321	8322	8323	8324	8325	8326	8328	8329	8330	8331	8332	24
25	8333	8334	8335	8336	8337	8338	8339	8340	8342	8343	8344	8345	25
26	8346	8347	8348	8349	8350	8351	8352	8353	8354	8356	8357	8358	26
27	8359	8360	8361	8362	8363	8364	8365	8366	8367	8368	8369	8370	27
28	8372	8373	8374	8375	8376	8377	8378	8379	8380	8381	8382	8383	28
29	8384	8385	8386	8387	8389	8390	8391	8392	8393	8394	8395	8396	29
30	9.8397	9.8398	9.8399	9.8400	9.8401	9.8402	9.8403	9.8404	9.8405	9.8406	9.8408	9.8409	30
31	8410	8411	8412	8413	8414	8415	8416	8417	8418	8419	8420	8421	31
32	8422	8423	8424	8425	8426	8427	8428	8429	8431	8432	8433	8434	32
33	8435	8436	8437	8438	8439	8440	8441	8442	8443	8444	8445	8446	33
34	8447	8448	8449	8450	8451	8452	8453	8454	8455	8456	8457	8459	34
35	8460	8461	8462	8463	8464	8465	8466	8467	8468	8469	8470	8471	35
36	8472	8473	8474	8475	8476	8477	8478	8479	8480	8481	8482	8483	36
37	8484	8485	8486	8487	8488	8489	8490	8491	8492	8493	8494	8495	37
38	8496	8497	8498	8499	8500	8501	8502	8503	8504	8505	8507	8508	38
39	8509	8510	8511	8512	8513	8514	8515	8516	8517	8518	8519	8520	39
40	9.8521	9.8522	9.8523	9.8524	9.8525	9.8526	9.8527	9.8528	9.8529	9.8530	9.8531	9.8532	40
41	8533	8534	8535	8536	8537	8538	8539	8540	8541	8542	8543	8544	41
42	8545	8546	8547	8548	8549	8550	8551	8552	8553	8554	8555	8556	42
43	8557	8558	8559	8560	8561	8562	8563	8564	8565	8566	8566	8567	43
44	8568	8569	8570	8571	8572	8573	8574	8575	8576	8577	8578	8579	44
45	8580	8581	8582	8583	8584	8585	8586	8587	8588	8589	8590	8591	45
46	8592	8593	8594	8595	8596	8597	8598	8599	8600	8601	8602	8603	46
47	8604	8605	8606	8607	8608	8609	8610	8611	8611	8612	8613	8614	47
48	8615	8616	8617	8618	8619	8620	8621	8622	8623	8624	8625	8626	48
49	8627	8628	8629	8630	8631	8632	8633	8634	8635	8636	8637	8638	49
50	9.8638	9.8639	9.8640	9.8641	9.8642	9.8643	9.8644	9.8645	9.8646	9.8647	9.8648	9.8649	50
51	8650	8651	8652	8653	8654	8655	8656	8657	8658	8659	8659	8660	51
52	8661	8662	8663	8664	8665	8666	8667	8668	8669	8670	8671	8672	52
53	8673	8674	8675	8676	8676	8677	8678	8679	8680	8681	8682	8683	53
54	8684	8685	8686	8687	8688	8689	8690	8691	8692	8692	8693	8694	54
55	8695	8696	8697	8698	8699	8700	8701	8702	8703	8704	8705	8706	55
56	8706	8707	8708	8709	8710	8711	8712	8713	8714	8715	8716	8717	56
57	8718	8719	8719	8720	8721	8722	8723	8724	8725	8726	8727	8728	57
58	8729	8730	8731	8731	8732	8733	8734	8735	8736	8737	8738	8739	58
59	8740	8741	8742	8742	8743	8744	8745	8746	8747	8748	8749	8750	59

MISCELLANEOUS TABLES.

TABLE XIX.

Proportional Logarithms for 24 Degrees or Hours.

Degrees, or Hours: or Minutes.

′ or ″	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	′ or ″
0		1.3802	1.0792	9031	7781	6812	6021	5351	4771	4260	3802	3388	3010	2663	2341	0
1	3.1584	1.3730	1.0756	9007	7763	6798	6009	5341	4762	4252	3795	3382	3004	2657	2336	1
2	2.8573	1.3660	1.0720	8983	7745	6784	5997	5330	4753	4244	3788	3375	2998	2652	2330	2
3	2.6812	1.3590	1.0685	8959	7728	6769	5985	5320	4744	4236	3780	3368	2992	2646	2325	3
4	2.5563	1.3522	1.0649	8935	7710	6755	5973	5309	4735	4228	3763	3362	2986	2640	2320	4
5	2.4594	1.3454	1.0614	8912	7692	6741	5961	5300	4726	4220	3766	3355	2980	2635	2315	5
6	2.3802	1.3388	1.0580	8888	7674	6726	5949	5289	4717	4212	3759	3349	2974	2629	2310	6
7	2.3133	1.3323	1.0546	8865	7657	6712	5937	5279	4708	4204	3752	3342	2968	2624	2305	7
8	2.2553	1.3259	1.0512	8842	7630	6698	5925	5269	4699	4196	3745	3336	2962	2618	2300	8
9	2.2041	1.3195	1.0478	8819	7622	6684	5913	5259	4690	4188	3737	3329	2956	2613	2295	9
10	2.1584	1.3133	1.0444	8796	7604	6670	5902	5249	4682	4180	3730	3323	2950	2607	2289	10
11	2.1170	1.3071	1.0411	8773	7587	6656	5890	5239	4673	4172	3723	3316	2944	2602	2284	11
12	2.0792	1.3010	1.0378	8751	7570	6642	5878	5229	4664	4164	3716	3309	2938	2596	2279	12
13	2.0444	1.2950	1.0345	8728	7552	6628	5866	5219	4655	4156	3709	3303	2933	2591	2274	13
14	2.0122	1.2891	1.0313	8706	7535	6614	5855	5209	4646	4148	3702	3297	2927	2585	2269	14
15	1.9823	1.2833	1.0280	8683	7518	6600	5843	5199	4638	4141	3695	3291	2921	2580	2264	15
16	1.9542	1.2775	1.0248	8661	7501	6587	5832	5189	4629	4133	3688	3284	2915	2574	2259	16
17	1.9279	1.2719	1.0216	8639	7484	6573	5820	5179	4620	4125	3681	3278	2909	2569	2254	17
18	1.9031	1.2663	1.0185	8617	7467	6559	5809	5169	4611	4117	3674	3271	2903	2564	2249	18
19	1.8796	1.2607	1.0153	8595	7451	6546	5797	5159	4603	4109	3667	3265	2897	2558	2244	19
20	1.8573	1.2553	1.0122	8573	7434	6532	5786	5149	4594	4102	3660	3258	2891	2553	2239	20
21	1.8361	1.2499	1.0091	8552	7417	6518	5774	5139	4585	4094	3653	3252	2885	2547	2234	21
22	1.8159	1.2445	1.0061	8530	7401	6505	5763	5129	4577	4086	3646	3246	2880	2542	2229	22
23	1.7966	1.2393	1.0030	8509	7384	6492	5752	5120	4568	4079	3639	3239	2874	2536	2223	23
24	1.7782	1.2341	1.0000	8487	7368	6478	5740	5110	4559	4071	3632	3233	2868	2531	2218	24
25	1.7604	1.2289	0.9970	8466	7351	6465	5729	5100	4551	4063	3625	3227	2862	2526	2213	25
26	1.7434	1.2239	0.9940	8445	7335	6451	5718	5090	4542	4055	3618	3220	2856	2520	2208	26
27	1.7270	1.2188	0.9910	8424	7318	6438	5706	5081	4534	4048	3611	3214	2850	2515	2203	27
28	1.7112	1.2139	0.9881	8403	7302	6425	5695	5071	4525	4040	3604	3208	2845	2510	2198	28
29	1.6960	1.2090	0.9852	8382	7286	6412	5684	5061	4516	4032	3597	3201	2839	2504	2193	29
30	1.6812	1.2041	0.9823	8361	7270	6398	5673	5051	4508	4025	3590	3195	2833	2499	2188	30
31	1.6670	1.1993	0.9794	8341	7254	6385	5662	5042	4499	4017	3583	3189	2827	2493	2183	31
32	1.6532	1.1946	0.9765	8320	7238	6372	5651	5032	4491	4010	3576	3183	2821	2488	2178	32
33	1.6398	1.1899	0.9737	8300	7222	6359	5640	5023	4482	4002	3570	3176	2816	2483	2173	33
34	1.6269	1.1852	0.9708	8279	7206	6346	5629	5013	4474	3994	3563	3170	2810	2477	2168	34
35	1.6143	1.1806	0.9680	8259	7190	6333	5618	5003	4466	3987	3556	3164	2804	2472	2163	35
36	1.6021	1.1761	0.9652	8239	7174	6320	5607	4994	4457	3979	3549	3157	2798	2467	2159	36
37	1.5902	1.1716	0.9625	8219	7159	6307	5596	4984	4449	3972	3542	3151	2793	2461	2154	37
38	1.5786	1.1671	0.9597	8199	7143	6294	5585	4975	4440	3964	3535	3145	2787	2456	2149	38
39	1.5673	1.1627	0.9570	8179	7128	6282	5574	4965	4432	3957	3529	3139	2781	2451	2144	39
40	1.5563	1.1584	0.9542	8159	7112	6269	5563	4956	4424	3949	3522	3133	2775	2445	2139	40
41	1.5456	1.1540	0.9515	8140	7097	6256	5552	4947	4415	3942	3515	3126	2770	2440	2134	41
42	1.5351	1.1498	0.9488	8120	7081	6243	5541	4937	4407	3934	3508	3120	2764	2435	2129	42
43	1.5249	1.1455	0.9462	8101	7066	6231	5531	4928	4399	3927	3501	3114	2758	2430	2124	43
44	1.5149	1.1413	0.9435	8081	7050	6218	5520	4918	4390	3919	3495	3108	2753	2424	2119	44
45	1.5051	1.1372	0.9408	8062	7035	6205	5509	4909	4382	3912	3488	3102	2747	2419	2114	45
46	1.4956	1.1331	0.9382	8043	7020	6193	5498	4900	4374	3905	3481	3096	2741	2414	2109	46
47	1.4863	1.1290	0.9356	8023	7005	6180	5488	4890	4365	3897	3475	3089	2736	2409	2104	47
48	1.4771	1.1249	0.9330	8004	6990	6168	5477	4881	4357	3890	3468	3083	2730	2403	2099	48
49	1.4682	1.1209	0.9305	7985	6975	6155	5466	4872	4349	3882	3461	3077	2724	2398	2095	49
50	1.4594	1.1170	0.9279	7966	6960	6143	5456	4863	4341	3875	3454	3071	2719	2393	2090	50
51	1.4508	1.1130	0.9254	7947	6945	6131	5445	4853	4333	3868	3448	3065	2713	2388	2085	51
52	1.4424	1.1091	0.9228	7929	6930	6118	5435	4844	4324	3860	3441	3059	2707	2382	2080	52
53	1.4341	1.1053	0.9203	7910	6915	6106	5424	4835	4316	3853	3434	3053	2702	2377	2075	53
54	1.4260	1.1015	0.9178	7891	6900	6094	5414	4826	4308	3846	3428	3047	2696	2372	2070	54
55	1.4180	1.0977	0.9153	7873	6885	6081	5403	4817	4300	3838	3421	3041	2690	2367	2065	55
56	1.4102	1.0940	0.9128	7854	6871	6069	5393	4808	4292	3831	3415	3034	2685	2362	2061	56
57	1.4025	1.0902	0.9104	7836	6856	6057	5382	4798	4284	3824	3408	3028	2679	2356	2056	57
58	1.3949	1.0865	0.9079	7818	6841	6045	5372	4789	4276	3817	3401	3022	2674	2351	2051	58
59	1.3875	1.0828	0.9055	7800	6827	6033	5361	4780	4268	3809	3395	3016	2668	2346	2046	59

TABLE XIX.

Proportional Logarithms for 24 Degrees or Hours.

Degrees or Hours : or Minutes.										
′ or ″	15	16	17	18	19	20	21	22	23	′ or ″
0	2041	1761	1498	1249	1015	0792	0580	0378	0185	0
1	2036	1756	1493	1245	1011	0788	0576	0375	0182	1
2	2031	1752	1489	1241	1007	0785	0573	0371	0179	2
3	2027	1747	1485	1237	1003	0781	0570	0368	0175	3
4	2022	1743	1481	1233	0999	0777	0566	0365	0172	4
5	2017	1738	1476	1229	0996	0774	0563	0361	0169	5
6	2012	1734	1472	1225	0992	0770	0559	0358	0166	6
7	2008	1729	1468	1221	0988	0767	0556	0355	0163	7
8	2003	1725	1464	1217	0984	0763	0552	0352	0160	8
9	1998	1720	1459	1213	0980	0759	0549	0348	0157	9
10	1993	1716	1455	1209	0977	0756	0546	0345	0153	10
11	1988	1711	1451	1205	0973	0753	0542	0342	0150	11
12	1984	1707	1447	1201	0969	0749	0539	0339	0147	12
13	1979	1702	1443	1197	0965	0745	0535	0335	0144	13
14	1974	1698	1438	1193	0962	0741	0532	0332	0141	14
15	1969	1694	1434	1189	0958	0738	0528	0329	0138	15
16	1965	1689	1430	1185	0954	0734	0525	0326	0135	16
17	1960	1685	1426	1181	0950	0731	0522	0322	0132	17
18	1955	1680	1422	1178	0947	0727	0518	0319	0128	18
19	1950	1676	1417	1174	0943	0724	0515	0316	0125	19
20	1946	1671	1413	1170	0939	0720	0511	0313	0122	20
21	1941	1667	1409	1166	0935	0716	0508	0309	0119	21
22	1936	1662	1405	1162	0932	0713	0505	0306	0116	22
23	1932	1658	1401	1158	0928	0709	0501	0303	0113	23
24	1927	1654	1397	1154	0924	0706	0498	0300	0110	24
25	1922	1649	1392	1150	0920	0702	0495	0296	0107	25
26	1917	1645	1388	1146	0917	0699	0491	0293	0104	26
27	1913	1640	1384	1142	0913	0695	0488	0290	0101	27
28	1908	1636	1380	1138	0909	0692	0484	0287	0098	28
29	1903	1632	1376	1134	0905	0688	0481	0283	0094	29
30	1899	1627	1372	1130	0902	0685	0478	0280	0091	30
31	1894	1623	1368	1126	0898	0681	0474	0277	0088	31
32	1889	1618	1363	1123	0895	0677	0471	0274	0085	32
33	1885	1614	1359	1119	0891	0674	0468	0271	0082	33
34	1880	1610	1355	1115	0887	0670	0464	0267	0079	34
35	1875	1605	1351	1111	0883	0667	0461	0264	0076	35
36	1871	1601	1347	1107	0880	0663	0458	0261	0073	36
37	1866	1597	1343	1103	0876	0660	0454	0258	0070	37
38	1862	1592	1339	1099	0872	0656	0451	0255	0067	38
39	1857	1588	1335	1095	0868	0653	0447	0251	0064	39
40	1852	1584	1331	1091	0865	0649	0444	0248	0061	40
41	1848	1579	1326	1088	0861	0646	0441	0245	0058	41
42	1843	1575	1322	1084	0858	0642	0438	0242	0055	42
43	1838	1571	1318	1080	0854	0639	0434	0239	0052	43
44	1834	1566	1314	1076	0850	0635	0431	0235	0048	44
45	1829	1562	1310	1072	0846	0632	0427	0232	0045	45
46	1825	1558	1306	1068	0843	0628	0424	0229	0042	46
47	1820	1553	1302	1064	0839	0625	0421	0226	0039	47
48	1816	1549	1298	1060	0835	0621	0418	0223	0036	48
49	1811	1545	1294	1057	0832	0618	0414	0220	0033	49
50	1806	1540	1290	1053	0828	0614	0411	0216	0030	50
51	1802	1536	1286	1049	0824	0611	0408	0213	0027	51
52	1797	1532	1282	1045	0821	0608	0404	0210	0024	52
53	1793	1527	1278	1041	0817	0604	0401	0207	0021	53
54	1788	1523	1274	1037	0814	0601	0398	0204	0018	54
55	1784	1519	1270	1034	0810	0597	0394	0201	0015	55
56	1779	1515	1265	1030	0806	0594	0391	0197	0012	56
57	1774	1510	1261	1026	0803	0590	0388	0194	0009	57
58	1770	1506	1257	1022	0799	0587	0384	0191	0006	58
59	1765	1502	1253	1018	0795	0583	0381	0188	0003	59

TABLE XX.

To reduce the Moon's Horizontal Parallax and Semidiameter to any given Greenwich Time.

Diff. in 12 Hours.	Greenwich Time. After Noon or Midnight.							
	h. 1	h. 2	h. 3	h. 4	h. 5	h. 6	h. 7	h. 8
	″	″	″	″	″	″	″	″
1	0	0	0	0	0	0	1	1
2	0	0	0	0	1	1	1	1
4	0	1	1	1	2	2	2	3
6	0	1	1	2	2	3	3	4
8	1	1	2	3	3	4	5	5
10	1	2	2	3	4	5	6	7
12	1	2	3	4	5	6	7	8
13	1	2	3	4	5	6	8	9
14	1	2	3	5	6	7	8	9
15	1	2	4	5	6	7	9	10
16	1	3	4	5	7	8	9	11
17	1	3	4	6	7	8	10	11
18	1	3	4	6	7	9	11	12
19	2	3	5	6	8	9	11	13
20	2	3	5	7	8	10	12	13
21	2	3	5	7	9	10	12	14
22	2	4	5	7	9	11	13	15
23	2	4	6	8	10	11	13	15
24	2	4	6	8	10	12	14	16
25	2	4	6	8	10	12	15	17
26	2	4	6	9	11	13	15	17
27	2	4	7	9	11	13	16	18
28	2	5	7	9	12	14	16	19
29	2	5	7	10	12	14	17	19
30	2	5	7	10	12	15	17	20

Diff. in 12 Hours.	Greenwich Time. After Noon or Midnight.							
	h. 9	h. 10	h. 11	′ 10	′ 20	′ 30	′ 40	′ 50
	″	″	″	″	″	″	″	″
1	1	1	1	0	0	0	0	0
2	2	2	2	0	0	0	0	0
4	3	3	4	0	0	0	0	0
6	5	5	6	0	0	0	0	0
8	6	7	7	0	0	0	0	1
10	8	8	9	0	0	0	1	1
12	9	10	11	0	0	0	1	1
13	10	11	12	0	0	1	1	1
14	11	12	13	0	0	1	1	1
15	11	13	14	0	0	1	1	1
16	12	13	15	0	0	1	1	1
17	13	14	16	0	0	1	1	1
18	14	15	17	0	0	1	1	1
19	14	16	17	0	1	1	1	1
20	15	17	18	0	1	1	1	1
21	16	18	19	0	1	1	1	2
22	17	18	20	0	1	1	1	2
23	17	19	21	0	1	1	1	2
24	18	20	22	0	1	1	1	2
25	19	21	23	0	1	1	1	2
26	20	22	24	0	1	1	1	2
27	20	23	25	0	1	1	1	2
28	21	23	26	0	1	1	2	2
29	22	24	27	0	1	1	2	2
30	23	25	28	0	1	1	2	2

TABLE XXI.

Proportional Logarithms for 1 Degree, or Hour.

		Index 1.						Index 0.								
″	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	12′	13′	14′	″
0		7782	4771	3010	1761	0792	1.0000	9331	8751	8239	7782	7368	6990	6642	6320	0
1	3.5563	7710	4735	2986	1743	0777	0.9988	9320	8742	8231	7774	7361	6984	6637	6315	1
2	3.2553	7639	4699	2962	1725	0763	0.9976	9310	8733	8223	7767	7354	6978	6631	6310	2
3	3.0792	7570	4664	2939	1707	0749	0.9964	9200	8724	8215	7760	7348	6972	6625	6305	3
4	2.9542	7501	4629	2915	1689	0734	0.9952	9289	8715	8207	7753	7341	6966	6620	6300	4
5	2.8573	7434	4594	2891	1671	0720	0.9940	9279	8706	8199	7745	7335	6960	6614	6294	5
6	2.7782	7368	4559	2868	1654	0706	0.9928	9269	8697	8191	7738	7328	6954	6609	6289	6
7	2.7112	7302	4525	2845	1636	0692	0.9916	9259	8688	8183	7731	7322	6948	6603	6284	7
8	2.6532	7238	4491	2821	1619	0678	0.9905	9249	8679	8175	7724	7315	6942	6598	6279	8
9	2.6021	7175	4457	2798	1601	0663	0.9893	9238	8670	8167	7717	7309	6936	6592	6274	9
10	2.5563	7112	4424	2775	1584	0649	0.9881	9228	8661	8159	7710	7302	6930	6587	6269	10
11	2.5149	7050	4390	2753	1566	0635	0.9869	9218	8652	8152	7703	7296	6924	6581	6264	11
12	2.4771	6990	4357	2730	1549	0621	0.9858	9208	8643	8144	7696	7289	6918	6576	6259	12
13	2.4424	6930	4325	2707	1532	0608	0.9846	9198	8635	8136	7688	7283	6912	6570	6254	13
14	2.4102	6871	4292	2685	1515	0594	0.9834	9188	8626	8128	7681	7276	6906	6565	6248	14
15	2.3802	6812	4260	2663	1498	0580	0.9823	9178	8617	8120	7674	7270	6900	6559	6243	15
16	2.3522	6755	4228	2640	1481	0566	0.9811	9168	8608	8112	7667	7264	6894	6554	6238	16
17	2.3259	6698	4196	2618	1464	0552	0.9800	9158	8599	8104	7660	7257	6888	6548	6233	17
18	2.3010	6642	4165	2596	1447	0539	0.9788	9148	8591	8097	7653	7251	6882	6543	6228	18
19	2.2775	6587	4133	2574	1430	0525	0.9777	9138	8582	8089	7646	7244	6877	6538	6223	19
20	2.2553	6532	4102	2553	1413	0512	0.9765	9128	8573	8081	7639	7238	6871	6532	6218	20
21	2.2341	6478	4071	2531	1397	0498	0.9754	9119	8565	8073	7632	7232	6865	6527	6213	21
22	2.2139	6425	4040	2510	1380	0484	0.9742	9109	8556	8066	7625	7225	6859	6521	6208	22
23	2.1946	6372	4010	2488	1363	0471	0.9731	9099	8547	8058	7618	7219	6853	6516	6203	23
24	2.1761	6320	3979	2467	1347	0458	0.9720	9089	8539	8050	7611	7212	6847	6510	6198	24
25	2.1584	6269	3949	2445	1331	0444	0.9708	9079	8530	8043	7604	7206	6841	6505	6193	25
26	2.1413	6218	3919	2424	1314	0431	0.9697	9070	8522	8035	7597	7200	6836	6500	6188	26
27	2.1249	6168	3890	2403	1298	0418	0.9686	9060	8513	8027	7590	7193	6830	6494	6183	27
28	2.1091	6118	3860	2382	1282	0404	0.9675	9050	8504	8020	7583	7187	6824	6489	6178	28
29	2.0939	6069	3831	2362	1266	0391	0.9664	9041	8496	8012	7577	7181	6818	6484	6173	29
30	2.0792	6021	3802	2341	1249	0378	0.9652	9031	8487	8004	7570	7175	6812	6478	6168	30
31	2.0649	5973	3773	2320	1233	0365	0.9641	9021	8479	7997	7563	7168	6807	6473	6163	31
32	2.0512	5925	3745	2300	1217	0352	0.9630	9012	8470	7989	7556	7162	6801	6467	6158	32
33	2.0378	5878	3716	2279	1201	0339	0.9619	9002	8462	7981	7549	7156	6795	6462	6153	33
34	2.0248	5832	3688	2259	1186	0326	0.9608	8992	8453	7974	7542	7149	6789	6457	6148	34
35	2.0122	5786	3660	2239	1170	0313	0.9597	8983	8445	7966	7535	7143	6784	6451	6143	35
36	2.0000	5740	3632	2218	1154	0300	0.9586	8973	8437	7959	7528	7137	6778	6446	6138	36
37	1.9881	5695	3604	2198	1138	0287	0.9575	8964	8428	7951	7522	7131	6772	6441	6133	37
38	1.9765	5651	3576	2178	1123	0274	0.9564	8954	8420	7944	7515	7124	6766	6435	6128	38
39	1.9652	5607	3549	2159	1107	0261	5.9553	8945	8411	7936	7508	7118	6761	6430	6123	39
40	1.9542	5563	3522	2139	1091	0248	0.9542	8935	8403	7929	7501	7112	6755	6425	6118	40
41	1.9435	5520	3495	2119	1076	0235	0.9532	8926	8395	7921	7494	7106	6749	6420	6113	41
42	1.9331	5477	3468	2099	1061	0223	0.9521	8917	8386	7914	7488	7100	6743	6414	6108	42
43	1.9228	5435	3441	2080	1045	0210	0.9510	8907	8378	7906	7481	7093	6738	6409	6103	43
44	1.9128	5393	3415	2061	1030	0197	0.9499	8898	8370	7899	7474	7087	6732	6404	6099	44
45	1.9031	5351	3388	2041	1015	0185	0.9488	8888	8361	7891	7467	7081	6726	6398	6094	45
46	1.8935	5310	3362	2022	0999	0172	0.9478	8879	8353	7884	7461	7075	6721	6393	6089	46
47	1.8842	5269	3336	2003	0984	0160	0.9467	8870	8345	7877	7454	7069	6715	6388	6084	47
48	1.8751	5229	3310	1984	0969	0147	0.9456	8861	8337	7869	7447	7063	6709	6383	6079	48
49	1.8661	5189	3284	1965	0954	0135	0.9446	8851	8328	7862	7441	7057	6704	6377	6074	49
50	1.8573	5149	3259	1946	0939	0122	0.9435	8842	8320	7855	7434	7050	6698	6372	6069	50
51	1.8487	5110	3233	1927	0924	0110	0.9425	8833	8312	7847	7427	7044	6692	6367	6064	51
52	1.8403	5071	3208	1908	0909	0098	0.9414	8824	8304	7840	7421	7038	6687	6362	6059	52
53	1.8320	5032	3183	1889	0894	0085	0.9404	8814	8296	7832	7414	7032	6681	6357	6055	53
54	1.8239	4994	3158	1871	0880	0073	0.9393	8805	8288	7825	7407	7026	6676	6351	6050	54
55	1.8159	4956	3133	1852	0865	0061	0.9383	8796	8279	7818	7401	7020	6670	6346	6045	55
56	1.8081	4918	3108	1834	0850	0049	0.9372	8787	8271	7811	7394	7014	6664	6341	6040	56
57	1.8004	4881	3083	1816	0835	0036	0.9362	8778	8263	7803	7387	7008	6659	6336	6035	57
58	1.7929	4844	3059	1797	0821	0024	0.9351	8769	8255	7796	7381	7002	6653	6331	6030	58
59	1.7855	4808	3034	1779	0806	0012	0.9341	8760	8247	7789	7374	6996	6648	6325	6025	59

TABLE XXI.

Proportional Logarithms for 1 Degree or Hour.

	Index 0.															
″	15′	16′	17′	18′	19′	20′	21′	22′	23′	24′	25′	26′	27′	28′	29′	″
0	6021	5740	5477	5229	4994	4771	4559	4357	4164	3979	3802	3632	3468	3310	3158	0
1	6016	5736	5473	5225	4990	4768	4556	4354	4161	3976	3799	3629	3465	3307	3155	1
2	6011	5731	5469	5221	4986	4764	4552	4351	4158	3973	3796	3626	3463	3305	3153	2
3	6006	5727	5464	5217	4983	4760	4549	4347	4155	3970	3793	3623	3460	3302	3150	3
4	6001	5722	5460	5213	4979	4757	4546	4344	4152	3967	3791	3621	3457	3300	3148	4
5	5997	5718	5456	5209	4975	4753	4542	4341	4149	3964	3788	3618	3454	3297	3145	5
6	5992	5713	5452	5205	4971	4750	4539	4338	4145	3961	3785	3615	3452	3294	3143	6
7	5987	5709	5447	5201	4967	4746	4535	4334	4142	3958	3782	3612	3449	3292	3140	7
8	5982	5704	5443	5197	4964	4742	4532	4331	4139	3955	3779	3610	3446	3289	3138	8
9	5977	5700	5439	5193	4960	4739	4528	4328	4136	3952	3776	3607	3444	3287	3135	9
10	5973	5695	5435	5189	4956	4735	4525	4325	4133	3949	3773	3604	3441	3284	3133	10
11	5968	5691	5430	5185	4952	4732	4522	4321	4130	3946	3770	3601	3438	3282	3130	11
12	5963	5686	5426	5181	4949	4728	4518	4318	4127	3943	3768	3598	3436	3279	3128	12
13	5958	5682	5422	5177	4945	4724	4515	4315	4124	3940	3765	3596	3433	3276	3125	13
14	5954	5677	5418	5173	4941	4721	4511	4311	4120	3937	3762	3593	3431	3274	3123	14
15	5949	5673	5414	5169	4937	4717	4508	4308	4117	3934	3759	3590	3428	3271	3120	15
16	5944	5669	5409	5165	4933	4714	4505	4305	4114	3931	3756	3587	3425	3269	3118	16
17	5939	5664	5405	5161	4930	4710	4501	4302	4111	3928	3753	3585	3423	3266	3115	17
18	5935	5660	5401	5157	4926	4707	4498	4298	4108	3925	3750	3582	3420	3264	3113	18
19	5930	5655	5397	5153	4922	4703	4494	4295	4105	3922	3747	3579	3417	3261	3110	19
20	5925	5651	5393	5149	4918	4699	4491	4292	4102	3919	3745	3576	3415	3259	3108	20
21	5920	5646	5389	5145	4915	4696	4488	4289	4099	3917	3742	3574	3412	3256	3105	21
22	5916	5642	5384	5141	4911	4692	4484	4285	4096	3914	3739	3571	3409	3253	3103	22
23	5911	5637	5380	5137	4907	4689	4481	4282	4092	3911	3736	3568	3407	3251	3101	23
24	5906	5633	5376	5133	4903	4685	4477	4279	4089	3908	3733	3565	3404	3248	3098	24
25	5902	5629	5372	5129	4900	4682	4474	4276	4086	3905	3730	3563	3401	3246	3096	25
26	5897	5624	5368	5125	4896	4678	4471	4273	4083	3902	3727	3560	3399	3243	3093	26
27	5892	5620	5364	5122	4892	4675	4467	4269	4080	3899	3725	3557	3396	3241	3091	27
28	5888	5615	5359	5118	4889	4671	4464	4266	4077	3896	3722	3555	3393	3238	3088	28
29	5883	5611	5355	5114	4885	4668	4460	4263	4074	3893	3719	3552	3391	3236	3086	29
30	5878	5607	5351	5110	4881	4664	4457	4260	4071	3890	3716	3549	3388	3233	3083	30
31	5874	5602	5347	5106	4877	4660	4454	4256	4068	3887	3713	3546	3386	3231	3081	31
32	5869	5598	5343	5102	4874	4657	4450	4253	4065	3884	3710	3544	3383	3228	3078	32
33	5864	5594	5339	5098	4870	4653	4447	4250	4062	3881	3708	3541	3380	3225	3076	33
34	5860	5589	5335	5094	4866	4650	4444	4247	4059	3878	3705	3538	3378	3223	3073	34
35	5855	5585	5331	5090	4863	4646	4444	4244	4055	3875	3702	3535	3375	3220	3071	35
36	5850	5580	5326	5086	4859	4643	4437	4240	4052	3872	3699	3533	3372	3218	3069	36
37	5846	5576	5322	5082	4855	4639	4434	4237	4049	3869	3696	3530	3370	3215	3066	37
38	5841	5572	5318	5079	4852	4636	4430	4234	4046	3866	3693	3527	3367	3213	3064	38
39	5836	5567	5314	5075	4848	4632	4427	4231	4043	3863	3691	3525	3365	3210	3061	39
40	5832	5563	5310	5071	4844	4629	4424	4228	4040	3860	3688	3522	3362	3208	3059	40
41	5827	5559	5306	5067	4841	4625	4420	4224	4037	3857	3685	3519	3359	3205	3056	41
42	5823	5554	5302	5063	4837	4622	4417	4221	4034	3855	3682	3516	3357	3203	3054	42
43	5818	5550	5298	5059	4833	4618	4414	4218	4031	3852	3679	3514	3354	3200	3052	43
44	5813	5546	5294	5055	4830	4615	4410	4215	4028	3849	3677	3511	3351	3198	3049	44
45	5809	5541	5290	5051	4826	4611	4407	4212	4025	3846	3674	3508	3349	3195	3047	45
46	5804	5537	5285	5048	4822	4608	4404	4209	4022	3843	3671	3506	3346	3193	3044	46
47	5800	5533	5281	5044	4819	4604	4400	4205	4019	3840	3668	3503	3344	3190	3042	47
48	5795	5528	5277	5040	4815	4601	4397	4202	4016	3837	3665	3500	3341	3188	3039	48
49	5790	5524	5273	5036	4811	4597	4394	4199	4013	3834	3663	3497	3338	3185	3037	49
50	5786	5520	5269	5032	4808	4594	4390	4196	4010	3831	3660	3495	3336	3183	3034	50
51	5781	5516	5265	5028	4804	4590	4387	4193	4007	3828	3657	3492	3333	3180	3032	51
52	5777	5511	5261	5025	4800	4587	4384	4189	4004	3825	3654	3489	3331	3178	3030	52
53	5772	5507	5257	5021	4797	4584	4380	4186	4001	3822	3651	3487	3328	3175	3027	53
54	5768	5503	5253	5017	4793	4580	4377	4183	3998	3820	3649	3484	3325	3173	3025	54
55	5763	5498	5249	5013	4789	4577	4374	4180	3995	3817	3646	3481	3323	3170	3022	55
56	5758	5494	5245	5009	4786	4573	4370	4177	3991	3814	3643	3479	3320	3168	3020	56
57	5754	5490	5241	5005	4782	4570	4367	4174	3988	3811	3640	3476	3318	3165	3018	57
58	5749	5486	5237	5002	4778	4566	4364	4171	3985	3808	3637	3473	3315	3163	3015	58
59	5745	5481	5233	4998	4775	4563	4361	4167	3982	3805	3635	3471	3313	3160	3013	59

TABLE XXI.

Proportional Logarithms for 1 Degree or Hour.

	Index 0.															
″	30′	31′	32′	33′	34′	35′	36′	37′	38′	39′	40′	41′	42′	43′	44′	″
0	3010	2868	2730	2596	2467	2341	2218	2099	1984	1871	1761	1654	1549	1447	1347	0
1	3008	2866	2728	2594	2465	2339	2216	2098	1982	1869	1759	1652	1547	1445	1345	1
2	3005	2863	2725	2592	2462	2337	2214	2096	1980	1867	1757	1650	1546	1443	1344	2
3	3003	2861	2723	2590	2460	2335	2212	2094	1978	1865	1755	1648	1544	1442	1342	3
4	3001	2859	2721	2588	2458	2333	2210	2092	1976	1863	1754	1647	1542	1440	1340	4
5	2998	2856	2719	2585	2456	2331	2208	2090	1974	1862	1752	1645	1540	1438	1339	5
6	2996	2854	2716	2583	2454	2328	2206	2088	1972	1860	1750	1643	1539	1437	1337	6
7	2993	2852	2714	2581	2452	2326	2204	2086	1970	1858	1748	1641	1537	1435	1335	7
8	2991	2849	2712	2579	2450	2324	2202	2084	1968	1856	1746	1640	1535	1433	1334	8
9	2989	2847	2710	2577	2448	2322	2200	2082	1967	1854	1745	1638	1534	1432	1332	9
10	2986	2845	2707	2574	2445	2320	2198	2080	1965	1852	1743	1636	1532	1430	1331	10
11	2984	2842	2705	2572	2443	2318	2196	2078	1963	1850	1741	1634	1530	1428	1329	11
12	2981	2840	2703	2570	2441	2316	2194	2076	1961	1849	1739	1633	1528	1427	1327	12
13	2979	2838	2701	2568	2439	2314	2192	2074	1959	1847	1737	1631	1527	1425	1326	13
14	2977	2835	2698	2566	2437	2312	2190	2072	1957	1845	1736	1629	1525	1423	1324	14
15	2974	2833	2696	2564	2435	2310	2188	2070	1955	1843	1734	1627	1523	1422	1322	15
16	2972	2831	2694	2561	2433	2308	2186	2068	1953	1841	1732	1626	1522	1420	1321	16
17	2969	2828	2692	2559	2431	2306	2184	2066	1951	1839	1730	1624	1520	1418	1319	17
18	2967	2826	2689	2557	2429	2304	2182	2064	1950	1838	1728	1622	1518	1417	1317	18
19	2965	2824	2687	2555	2426	2302	2180	2062	1948	1836	1727	1620	1516	1415	1316	19
20	2962	2821	2685	2553	2424	2300	2178	2061	1946	1834	1725	1619	1515	1413	1314	20
21	2960	2819	2683	2551	2422	2298	2176	2059	1944	1832	1723	1617	1513	1412	1313	21
22	2958	2817	2681	2548	2420	2296	2174	2057	1942	1830	1721	1615	1511	1410	1311	22
23	2955	2815	2678	2546	2418	2294	2172	2055	1940	1828	1719	1613	1510	1408	1309	23
24	2953	2812	2676	2544	2416	2291	2170	2053	1938	1827	1718	1612	1508	1407	1308	24
25	2950	2810	2674	2542	2414	2289	2169	2051	1936	1825	1716	1610	1506	1405	1306	25
26	2948	2808	2672	2540	2412	2287	2167	2049	1934	1823	1714	1608	1504	1403	1304	26
27	2946	2805	2669	2538	2410	2285	2165	2047	1933	1821	1712	1606	1503	1402	1303	27
28	2943	2803	2667	2535	2408	2283	2163	2045	1931	1819	1711	1605	1501	1400	1301	28
29	2941	2801	2665	2533	2405	2281	2161	2043	1929	1817	1709	1603	1499	1398	1300	29
30	2939	2798	2663	2531	2403	2279	2159	2041	1927	1816	1707	1601	1498	1397	1298	30
31	2936	2796	2660	2529	2401	2277	2157	2039	1925	1814	1705	1599	1496	1395	12: 6	31
32	2934	2794	2658	2527	2399	2275	2155	2037	1923	1812	1703	1598	1494	1393	1295	32
33	2931	2792	2656	2525	2397	2273	2153	2035	1921	1810	1702	1596	1493	1392	1293	33
34	2929	2789	2654	2522	2395	2271	2151	2033	1919	1808	1700	1594	1491	1390	1291	34
35	2927	2787	2652	2520	2393	2269	2149	2032	1918	1806	1698	1592	1489	1388	1290	35
36	2924	2785	2649	2518	2391	2267	2147	2030	1916	1805	1696	1591	1487	1387	1288	36
37	2922	2782	2647	2516	2389	2265	2145	2028	1914	1803	1694	1589	1486	1385	1287	37
38	2920	2780	2645	2514	2387	2263	2143	2026	1912	1801	1693	1587	1484	1383	1285	38
39	2917	2778	2643	2512	2384	2261	2141	2024	1910	1799	1691	1585	1482	1382	1283	39
40	2915	2775	2640	2510	2382	2259	2139	2022	1908	1797	1689	1584	1481	1380	1282	40
41	2912	2773	2638	2507	2380	2257	2137	2020	1906	1795	1687	1582	1479	1378	1280	41
42	2910	2771	2636	2505	2378	2255	2135	2018	1904	1794	1686	1580	1477	1377	1278	42
43	2908	2769	2634	2503	2376	2253	2133	2016	1903	1792	1684	1578	1476	1375	1277	43
44	2905	2766	2632	2501	2374	2251	2131	2014	1901	1790	1682	1577	1474	1373	1275	44
45	2903	2764	2629	2499	2372	2249	2129	2012	1899	1788	1680	1575	1472	1372	1274	45
46	2901	2762	2627	2497	2370	2247	2127	2010	1897	1786	1678	1573	1470	1370	1272	46
47	2898	2760	2625	2494	2368	2245	2125	2009	1895	1785	1677	1571	1469	1368	1270	47
48	2896	2757	2623	2492	2366	2243	2123	2007	1893	1783	1675	1570	1467	1367	1269	48
49	2894	2755	2621	2490	2364	2241	2121	2005	1891	1781	1673	1568	1465	1365	1267	49
50	2891	2753	2618	2488	2362	2239	2119	2003	1889	1779	1671	1566	1464	1363	1266	50
51	2889	2750	2616	2486	2359	2237	2117	2001	1888	1777	1670	1565	1462	1362	1264	51
52	2887	2748	2614	2484	2357	2235	2115	1999	1886	1775	1668	1563	1460	1360	1262	52
53	2884	2746	2612	2482	2355	2233	2113	1997	1884	1774	1666	1561	1459	1359	1261	53
54	2882	2744	2610	2480	2353	2231	2111	1995	1882	1772	1664	1559	1457	1357	1259	54
55	2880	2741	2607	2477	2351	2229	2109	1993	1880	1770	1663	1558	1455	1355	1257	55
56	2877	2739	2605	2475	2349	2227	2107	1991	1878	1768	1661	1556	1454	1354	1256	56
57	2875	2737	2603	2473	2347	2225	2105	1989	1876	1766	1659	1554	1452	1352	1254	57
58	2873	2735	2601	2471	2345	2223	2103	1987	1875	1765	1657	1552	1450	1350	1253	58
59	2870	2732	2599	2469	2343	2220	2101	1986	1873	1763	1655	1551	1449	1349	1251	59

TABLE XXI.

Proportional Logarithms for 1 Degree or Hour.

	Index 0.															
″	45′	46′	47′	48′	49′	50′	51′	52′	53′	54′	55′	56′	57′	58′	59′	″
0	1249	1154	1061	0969	0880	0792	0706	0621	0539	0458	0378	0300	0223	0147	0073	0
1	1248	1152	1059	0968	0878	0790	0704	0620	0537	0456	0377	0298	0221	0146	0072	1
2	1246	1151	1057	0966	0877	0789	0703	0619	0536	0455	0375	0297	0220	0145	0071	2
3	1245	1149	1056	0965	0875	0787	0702	0617	0535	0454	0374	0296	0219	0143	0069	3
4	1243	1148	1054	0963	0874	0786	0700	0616	0533	0452	0373	0294	0218	0142	0068	4
5	1241	1146	1053	0962	0872	0785	0699	0615	0532	0451	0371	0293	0216	0141	0067	5
6	1240	1145	1051	0960	0871	0783	0697	0613	0531	0450	0370	0292	0215	0140	0066	6
7	1238	1143	1050	0959	0869	0782	0696	0612	0529	0448	0369	0291	0214	0139	0064	7
8	1237	1141	1048	0957	0868	0780	0694	0610	0528	0447	0367	0289	0213	0137	0063	8
9	1235	1140	1047	0956	0866	0779	0693	0609	0526	0446	0366	0288	0211	0136	0062	9
10	1233	1138	1045	0954	0865	0777	0692	0608	0525	0444	0365	0287	0210	0135	0061	10
11	1232	1137	1044	0953	0863	0776	0690	0606	0524	0443	0363	0285	0209	0134	0060	11
12	1230	1135	1042	0951	0862	0774	0689	0605	0522	0442	0362	0284	0208	0132	0058	12
13	1229	1134	1041	0950	0860	0773	0687	0603	0521	0440	0361	0283	0206	0131	0057	13
14	1227	1132	1039	0948	0859	0772	0686	0602	0520	0439	0359	0282	0205	0130	0056	14
15	1225	1130	1037	0947	0857	0770	0685	0601	0518	0438	0358	0280	0204	0129	0055	15
16	1224	1129	1036	0945	0856	0769	0683	0599	0517	0436	0357	0279	0202	0127	0053	16
17	1222	1127	1034	0944	0855	0767	0682	0598	0516	0435	0356	0278	0201	0126	0052	17
18	1221	1126	1033	0942	0853	0766	0680	0596	0514	0434	0354	0276	0200	0125	0051	18
19	1219	1124	1031	0941	0852	0764	0679	0595	0513	0432	0353	0275	0199	0124	0050	19
20	1217	1123	1030	0939	0850	0763	0678	0594	0512	0431	0352	0274	0197	0122	0049	20
21	1216	1121	1028	0938	0849	0762	0676	0592	0510	0430	0350	0273	0196	0121	0047	21
22	1214	1119	1027	0936	0847	0760	0675	0591	0509	0428	0349	0271	0195	0120	0046	22
23	1213	1118	1025	0935	0846	0759	0673	0590	0507	0427	0348	0270	0194	0119	0045	23
24	1211	1116	1024	0933	0844	0757	0672	0588	0506	0426	0346	0269	0192	0117	0044	24
25	1209	1115	1022	0932	0843	0756	0670	0587	0505	0424	0345	0267	0191	0116	0042	25
26	1208	1113	1021	0930	0841	0754	0669	0585	0503	0423	0344	0266	0190	0115	0041	26
27	1206	1112	1019	0929	0840	0753	0668	0584	0502	0422	0342	0265	0189	0114	0040	27
28	1205	1110	1018	0927	0838	0751	0666	0583	0501	0420	0341	0264	0187	0112	0039	28
29	1203	1109	1016	0926	0837	0750	0665	0581	0499	0419	0340	0262	0186	0111	0038	29
30	1201	1107	1015	0924	0835	0749	0663	0580	0498	0418	0339	0261	0185	0110	0036	30
31	1200	1105	1013	0923	0834	0747	0662	0579	0497	0416	0337	0260	0184	0109	0035	31
32	1198	1104	1012	0921	0833	0746	0661	0577	0495	0415	0336	0258	0182	0107	0034	32
33	1197	1102	1010	0920	0831	0744	0659	0576	0494	0414	0335	0257	0181	0106	0033	33
34	1195	1101	1008	0918	0830	0743	0658	0574	0493	0412	0333	0256	0180	0105	0031	34
35	1193	1099	1007	0917	0828	0741	0656	0573	0491	0411	0332	0255	0179	0104	0030	35
36	1192	1098	1005	0915	0827	0740	0655	0572	0490	0410	0331	0253	0177	0103	0029	36
37	1190	1096	1004	0914	0825	0739	0654	0570	0489	0408	0329	0252	0176	0101	0028	37
38	1189	1095	1002	0912	0824	0737	0652	0569	0487	0407	0328	0251	0175	0100	0027	38
39	1187	1093	1001	0911	0822	0736	0651	0568	0486	0406	0327	0250	0174	0099	0025	39
40	1186	1091	0999	0909	0821	0734	0649	0566	0484	0404	0326	0248	0172	0098	0024	40
41	1184	1090	0998	0908	0819	0733	0648	0565	0483	0403	0324	0247	0171	0096	0023	41
42	1182	1088	0996	0906	0818	0731	0647	0563	0482	0402	0323	0246	0170	0095	0022	42
43	1181	1087	0995	0905	0816	0730	0645	0562	0480	0400	0322	0244	0169	0094	0021	43
44	1179	1085	0993	0903	0815	0729	0644	0561	0479	0399	0320	0243	0167	0093	0019	44
45	1178	1084	0992	0902	0814	0727	0642	0559	0478	0398	0319	0242	0166	0091	0018	45
46	1176	1082	0990	0900	0812	0726	0641	0558	0476	0396	0318	0241	0165	0090	0017	46
47	1174	1081	0989	0899	0811	0724	0640	0557	0475	0395	0316	0239	0163	0089	0016	47
48	1173	1079	0987	0897	0809	0723	0638	0555	0474	0394	0315	0238	0162	0088	0015	48
49	1171	1078	0986	0896	0808	0721	0637	0554	0472	0392	0314	0237	0161	0087	0013	49
50	1170	1076	0984	0894	0806	0720	0635	0552	0471	0391	0313	0235	0160	0085	0012	50
51	1168	1074	0983	0893	0805	0719	0634	0551	0470	0390	0311	0234	0158	0084	0011	51
52	1167	1073	0981	0891	0803	0717	0633	0550	0468	0388	0310	0233	0157	0083	0010	52
53	1165	1071	0980	0890	0802	0716	0631	0548	0467	0387	0309	0232	0156	0082	0008	53
54	1163	1070	0978	0888	0801	0714	0630	0547	0466	0386	0307	0230	0155	0080	0007	54
55	1162	1068	0977	0887	0799	0713	0628	0546	0464	0384	0306	0229	0153	0079	0006	55
56	1160	1067	0975	0885	0798	0711	0627	0544	0463	0383	0305	0228	0152	0078	0005	56
57	1159	1065	0974	0884	0796	0710	0626	0543	0462	0382	0304	0227	0151	0077	0004	57
58	1157	1064	0972	0883	0795	0709	0624	0541	0460	0381	0302	0225	0150	0075	0002	58
59	1156	1062	0971	0881	0793	0707	0623	0540	0459	0379	0301	0224	0148	0074	0001	59

TABLE XXII.

Departure of the Moon in Altitude.

☾'s Alt.	Moon's Horizontal Parallax.										☾'s Alt.	Moon's Horizontal Parallax.									
	53′	54′	55′	56′	57′	58′	59′	60′	61′	62′		53′	54′	55′	56′	57′	58′	59′	60′	61′	62′
°	′	′	′	′	′	′	′	′	′	′	°	′	′	′	′	′	′	′	′	′	′
5	37	38	40	41	42	43	44	45	46	47	56	29	29	30	31	31	32	32	33	33	34
6	39	40	42	43	44	45	46	47	48	49	57	28	29	29	30	30	31	31	32	32	33
7	41	42	43	44	46	47	48	49	50	51	58	27	28	28	29	29	30	31	31	32	32
8	43	44	45	46	47	48	49	50	51	52	59	27	27	28	28	29	29	30	30	31	31
9	44	45	46	47	48	49	50	51	52	53	60	26	26	27	27	28	28	29	29	30	30
10	45	46	47	48	49	50	51	52	53	54	61	25	25	26	26	27	27	28	28	29	29
12	46	47	48	49	50	51	52	53	54	55	62	24	25	25	26	26	27	27	28	28	28
14	46	48	49	50	51	52	53	54	55	56	63	23	24	24	25	25	26	26	27	27	28
16	47	48	49	50	51	52	53	54	55	56	64	23	23	23	24	24	25	25	26	26	27
18	47	48	49	50	51	52	52	53	54	55	65	22	22	23	23	23	24	24	25	25	26
20	46	47	48	49	50	51	52	53	54	55	66	21	21	22	22	23	23	23	24	24	25
22	46	47	48	49	50	51	52	53	54	55	67	20	21	21	21	22	22	22	23	23	24
24	45	46	47	48	49	50	51	52	53	54	68	19	20	20	20	21	21	22	22	22	23
26	45	46	47	48	49	49	50	51	52	53	69	18	19	19	20	20	20	21	21	21	22
28	44	45	46	47	48	49	50	51	51	52	70	18	18	18	19	19	19	20	20	20	21
30	44	45	45	46	47	48	49	50	51	52	71	17	17	17	18	18	18	19	19	19	20
32	43	44	45	45	46	47	48	49	50	51	72	16	16	17	17	17	17	18	18	18	19
34	42	43	44	45	45	46	47	48	49	50	73	15	15	16	16	16	17	17	17	17	18
36	41	42	43	44	44	45	46	47	48	49	74	14	14	15	15	15	16	16	16	16	17
38	40	41	42	43	43	44	45	46	46	47	75	13	14	14	14	14	15	15	15	15	16
40	39	40	41	42	42	43	44	44	45	46	76	12	13	13	13	13	14	14	14	14	15
42	38	39	40	40	41	42	43	43	44	45	77	12	12	12	12	12	13	13	13	13	14
43	37	38	39	40	40	41	42	43	43	44	78	11	11	11	11	11	12	12	12	12	13
44	37	38	38	39	40	41	41	42	43	43	79	10	10	10	10	11	11	11	11	11	11
45	36	37	38	38	39	40	41	41	42	43	80	9	9	9	9	10	10	10	10	10	10
46	36	36	37	38	39	39	40	41	41	42	81	8	8	8	8	9	9	9	9	9	9
47	35	36	36	37	38	39	39	40	41	41	82	7	7	7	7	8	8	8	8	8	8
48	34	35	36	36	37	38	38	39	40	40	83	6	6	6	6	7	7	7	7	7	7
49	34	34	35	36	36	37	38	38	39	40	84	5	5	5	6	6	6	6	6	6	6
50	33	34	34	35	36	36	37	38	38	39	85	4	4	5	5	5	5	5	5	5	5
51	32	33	34	34	35	36	36	37	37	38	86	3	4	4	4	4	4	4	4	4	4
52	32	32	33	34	34	35	35	36	37	37	87	3	3	3	3	3	3	3	3	3	3
53	31	32	32	33	33	34	35	35	36	36	88	2	2	2	2	2	2	2	2	2	2
54	30	31	31	32	33	33	34	34	35	36	89	1	1	1	1	1	1	1	1	1	1
55	30	30	31	31	32	32	33	34	34	35	90	0	0	0	0	0	0	0	0	0	0

TABLE XXIII.

Correction of 2d Auxiliary Arc.

☀'s App. Alt.	Moon's Apparent Altitude.									
	5°	10°	20°	30°	40°	50°	60°	70°	80°	90°
°	″	″	″	″	″	″	″	″	″	″
5	+ 8	+ 9	+ 8	+ 7	+ 6	+ 4	+ 2	+ 1	+ 0	— 0
6	7	7	7	6	5	3	2	1	0	— 0
7	6	6	6	5	4	3	2	1	0	— 0
8	5	6	5	5	4	3	2	1	0	— 0
10	4	5	4	4	3	2	1	1	0	— 0
15	3	3	3	2	2	1	1	0	— 0	— 0
20	2	2	2	2	1	1	0	0	— 0	— 0
25	2	2	2	1	1	1	0	— 0	— 0	— 0
30	1	1	1	1	1	0	0	— 0	— 0	— 1
40	1	1	1	1	0	0	— 0	— 0	— 1	— 1
50	1	1	0	0	0	— 0	— 0	— 1	— 1	— 1
60	0	0	0	0	— 0	— 0	— 0	— 1	— 1	— 1
70	0	0	0	— 0	— 0	— 0	— 1	— 1	— 1	— 1
80	0	0	— 0	— 0	— 0	— 1	— 1	— 1	— 1	— 1
90	— 0	— 0	— 0	— 0	— 0	— 1	— 1	— 1	— 1	— 1

TABLE XXIV.

The Star's Correction to be added to the Observed or Apparent Distance.

Distance 20°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	10°	20°	30°	40°	50°
	″	″	″	″	″	″
6°	30	31	30	27	..	..
7	26	27	26	22	..	..
8	22	23	22	20	..	..
9	19	20	19	17	..	..
10	17	17	17	15	..	..
15	10	10	10	9	7	..
20	7	7	7	6	5	4
25	5	6	6	4	4	3
30	4	4	4	4	2	2
40	2	3	2	2	1	0

Distance 22°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	10°	20°	30°	40°	50°
	″	″	″	″	″	″
6°	27	28	27	25	..	..
7	23	24	23	21	..	..
8	20	21	20	18	..	..
9	17	18	17	16	13	..
10	15	15	15	14	12	..
15	9	9	9	8	7	..
20	6	6	6	6	4	3
25	5	5	5	4	3	2
30	4	4	4	3	2	2
40	2	2	2	2	1	0

Distance 25°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	10°	20°	30°	40°	50°
	″	″	″	″	″	″
6°	25	25	24	22	..	..
7	21	21	21	19	16	..
8	17	18	17	16	13	..
9	15	16	15	14	12	..
10	13	14	13	12	10	..
15	8	8	8	7	6	..
20	6	6	6	5	4	3
25	5	5	5	4	3	2
30	4	4	3	3	2	1
40	2	2	2	1	1	0

Distance 27°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	10°	20°	30°	40°	50°
	″	″	″	″	″	″
6°	23	23	23	21	18	..
7	20	20	20	18	16	..
8	17	18	17	15	13	..
9	15	16	15	13	11	..
10	13	14	13	11	10	..
15	8	8	8	7	6	4
20	6	6	6	5	4	3
25	4	4	4	4	3	2
30	3	3	3	3	2	1
40	2	2	2	1	1	0

Distance 30°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	10°	20°	30°	40°	50°
	″	″	″	″	″	″
6°	20	20	20	18	16	..
7	17	17	17	16	13	..
8	15	15	15	13	11	..
9	13	13	13	11	10	..
10	11	11	11	10	8	..
15	7	7	7	6	5	4
20	5	5	5	4	3	2
25	4	4	4	3	2	2
30	3	3	3	2	2	1
40	2	2	2	1	1	0

Distance 35°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	20°	30°	40°	50°	60°
	″	″	″	″	″	″
6°	19	19	17	15	12	..
7	16	16	14	12	10	..
8	13	13	12	10	8	..
9	12	12	11	9	7	..
10	10	10	9	8	6	..
15	6	6	5	4	3	..
20	4	4	4	3	2	2
25	4	4	3	2	2	1
30	3	3	2	1	1	1
40	1	1	1	1	0	0

Distance 40°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	20°	30°	40°	50°	60°
	″	″	″	″	″	″
6°	15	15	14	12	10	..
7	13	13	12	10	8	..
8	11	11	10	8	7	..
9	10	10	9	7	6	..
10	8	8	8	6	5	..
15	5	5	5	4	3	2
20	4	4	3	3	2	1
25	3	3	3	2	1	1
30	2	2	2	1	1	0
40	1	1	1	1	0	0

Distance 50°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	20°	30°	40°	50°	60°
	″	″	″	″	″	″
6°	12	12	11	9	7	6
7	10	10	9	8	6	5
8	9	9	8	7	5	4
9	8	8	7	6	5	3
10	7	7	6	5	4	3
15	4	4	4	3	2	1
20	3	3	2	2	1	1
25	2	2	2	1	1	1
30	2	2	1	1	1	0
40	1	1	1	0	0	0

Distance 60°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	20°	30°	40°	50°	60°
	″	″	″	″	″	″
6°	10	10	9	8	6	4
7	9	9	8	7	5	4
8	8	8	7	6	4	3
9	8	8	6	5	4	3
10	6	6	5	4	3	2
15	4	4	3	2	2	1
20	3	3	2	2	1	1
25	2	2	2	1	1	1
30	2	2	1	1	1	0
40	1	1	1	0	0	0

Distance 70°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	30°	40°	50°	60°	70°
	″	″	″	″	″	″
6°	9	8	6	5	3	2
7	8	8	6	4	3	2
8	7	6	5	4	3	2
9	6	5	4	3	2	1
10	5	5	4	3	2	1
15	3	3	2	1	1	1
20	2	2	2	1	1	0
25	2	1	1	1	0	0
30	1	1	1	1	0	0
40	1	1	1	0	0	0

Distance 80°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	30°	40°	50°	60°	70°
	″	″	″	″	″	″
6°	8	7	5	4	3	2
7	7	6	5	3	2	1
8	6	5	4	3	2	1
9	5	4	4	3	2	1
10	5	4	3	2	1	1
15	3	3	2	1	1	0
20	2	2	1	1	1	0
25	2	1	1	1	0	0
30	1	1	1	0	0	0
40	1	1	0	0	0	0

Distance 90°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	30°	40°	50°	60°	70°
	″	″	″	″	″	″
6°	7	7	5	3	2	1
7	6	6	4	3	2	1
8	5	5	4	3	2	1
9	5	5	3	2	1	1
10	4	4	3	2	1	1
15	3	3	2	1	1	0
20	2	2	1	1	0	0
25	2	2	1	1	0	0
30	1	1	1	0	0	0
40	1	1	0	0	0	0

Distance 100°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	30°	40°	50°	60°	70°
	″	″	″	″	″	″
6°	7	6	4	3	1	0
7	6	5	4	2	1	0
8	5	4	3	2	1	0
9	5	4	3	2	1	0
10	4	3	3	2	1	0
15	3	2	2	1	1	0
20	2	2	1	1	1	0
25	1	1	1	0	0	0
30	1	1	1	0	0	0
40	1	1	1	0	0	0

Distance 110°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	30°	40°	50°	60°	70°
	″	″	″	″	″	″
6°	6	5	4	2	1	0
7	5	5	3	2	1	0
8	5	4	3	2	1	0
9	5	3	3	2	1	0
10	4	3	2	1	1	0
15	3	2	2	1	1	0
20	2	2	1	1	0	0
25	1	1	1	0	0	0
30	1	1	1	0	0	0
40	1	1	0	0	0	0

Distance 120°

⊙, or *'s Alt.	☽'s Altitude.					
	6°	30°	40°	50°	60°	70°
	″	″	″	″	″	″
6°	6	5	4	2	0	0
7	5	5	3	2	0	0
8	5	4	3	2	0	0
9	4	4	3	2	0	0
10	4	3	2	1	0	0
15	3	2	2	1	0	0
20	2	2	1	1	0	0
25	1	1	1	0	0	0
30	1	1	1	0	0	0
40	1	1	0	0	0	0

TABLE XXV.

Equation of Altitude.

1st Auxiliary Arc always W.
2d Auxiliary Arc always E.

3d Aux. Arc. { E when Distance less than 90°. / W when Distance greater than 90°.

Alt.	Equat.	Alt.	Equat.	Alt.	Equat.	Alt.	Equat.	Alt.	Equat.	Alt.	Equat.	Alt.	Equat.	Alt.	Equat.
6° 0′	8′ 29″	8° 0′	6′ 34″	10° 0′	5′ 20″	12° 0′	4′ 29″	17° 0′	3′ 13″	23° 0′	2′ 25″	33° 0′	1′ 44″	61°	1′ 5″
2	8 27	2	6 32	2	5 19	5	4 27	5	3 13	10	2 24	20	1 43	62	1 4
4	8 25	4	6 31	4	5 18	10	4 26	10	3 12	20	2 23	40	1 42	63	1 4
6	8 22	6	6 29	6	5 17	15	4 24	15	3 11	30	2 22	34 0	1 41	64	1 3
8	8 20	8	6 28	8	5 16	20	4 22	20	3 10	40	2 21	20	1 40	65	1 3
10	8 17	10	6 26	10	5 15	25	4 20	25	3 9	50	2 20	40	1 39	66	1 2
6 12	8 15	8 12	6 25	10 12	5 14	12 30	4 19	17 30	3 8	24 0	2 19	35 0	1 38	67	1 2
14	8 13	14	6 23	14	5 13	35	4 17	35	3 7	10	2 18	20	1 38	68	1 1
16	8 10	16	6 22	16	5 12	40	4 15	40	3 6	20	2 17	40	1 37	69	1 1
18	8 8	18	6 20	18	5 11	45	4 13	45	3 5	30	2 16	36 0	1 36	70	1 1
20	8 6	20	6 19	20	5 10	50	4 12	50	3 5	40	2 16	20	1 35	71	1 0
22	8 3	22	6 17	22	5 9	55	4 10	55	3 4	50	2 15	40	1 35	72	1 0
6 24	8 1	8 24	6 16	10 24	5 8	13 0	4 9	18 0	3 3	25 0	2 14	37 0	1 34	73	1 0
26	7 59	26	6 15	26	5 7	5	4 7	5	3 2	10	2 13	20	1 34	74	0 59
28	7 57	28	6 13	28	5 6	10	4 6	10	3 1	20	2 12	40	1 33	75	0 59
30	7 54	30	6 12	30	5 5	15	4 5	15	3 0	30	2 11	38 0	1 33	76	0 59
32	7 52	32	6 11	32	5 4	20	4 4	20	3 0	40	2 11	20	1 32	77	0 59
34	7 50	34	6 9	34	5 3	25	4 2	25	2 59	50	2 10	40	1 31	78	0 58
6 36	7 48	8 36	6 8	10 36	5 2	13 30	4 1	18 30	2 58	26 0	2 9	39 0	1 31	79	0 58
38	7 46	38	6 7	38	5 2	35	3 59	35	2 57	10	2 8	20	1 30	80	0 58
40	7 44	40	6 5	40	5 1	40	3 58	40	2 56	20	2 8	40	1 30	81	0 58
42	7 42	42	6 4	42	5 0	45	3 56	45	2 56	30	2 7	40 0	1 29	82	0 58
44	7 40	44	6 3	44	4 59	50	3 55	50	2 55	40	2 6	20	1 28	83	0 57
46	7 38	46	6 1	46	4 58	55	3 54	55	2 54	50	2 5	40	1 28	84	0 57
6 48	7 36	8 48	6 0	10 48	4 57	14 0	3 52	19 0	2 53	27 0	2 4	41 0	1 27	85	0 57
50	7 34	50	5 59	50	4 56	5	3 51	5	2 53	10	2 3	20	1 26	86	0 57
52	7 32	52	5 57	52	4 55	10	3 50	10	2 52	20	2 3	40	1 26	87	0 57
54	7 30	54	5 56	54	4 54	15	3 48	15	2 51	30	2 2	42 0	1 25	88	0 57
56	7 28	56	5 55	56	4 54	20	3 47	20	2 51	40	2 1	20	1 25	89	0 57
58	7 26	58	5 54	58	4 53	25	3 46	25	2 50	50	2 1	40	1 24	90	0 57
7 0	7 24	9 0	5 52	11 0	4 52	14 30	3 45	19 30	2 49	28 0	2 0	43 0	1 24		
2	7 22	2	5 51	2	4 51	35	3 43	35	2 48	10	2 0	30	1 23		
4	7 20	4	5 50	4	4 50	40	3 42	40	2 48	20	1 59	44 0	1 22		
6	7 19	6	5 49	6	4 49	45	3 41	45	2 47	30	1 58	30	1 22		
8	7 17	8	5 48	8	4 48	50	3 40	50	2 46	40	1 58	45 0	1 21		
10	7 15	10	5 46	10	4 48	55	3 38	55	2 46	50	1 57	30	1 20		
7 12	7 14	9 12	5 45	11 12	4 47	15 0	3 37	20 0	2 45	29 0	1 57	46 0	1 19		
14	7 12	14	5 44	14	4 46	5	3 36	5	2 44	10	1 56	30	1 19		
16	7 10	16	5 43	16	4 45	10	3 35	10	2 44	20	1 55	47 0	1 18		
18	7 8	18	5 42	18	4 45	15	3 34	15	2 43	30	1 55	30	1 18		
20	7 6	20	5 41	20	4 44	20	3 33	20	2 42	40	1 54	48 0	1 17		
22	7 5	22	5 40	22	4 43	25	3 32	25	2 42	50	1 53	30	1 16		
7 24	7 3	9 24	5 39	11 24	4 43	15 30	3 31	20 30	2 41	30 0	1 53	49 0	1 15		
26	7 1	26	5 38	26	4 42	35	3 30	35	2 40	10	1 52	30	1 15		
28	6 59	28	5 37	28	4 41	40	3 29	40	2 40	20	1 52	50 0	1 14		
30	6 58	30	5 36	30	4 41	45	3 28	45	2 39	30	1 51	30	1 14		
32	6 56	32	5 35	32	4 40	50	3 27	50	2 38	40	1 51	51 0	1 13		
34	6 54	34	5 34	34	4 39	55	3 26	55	2 38	50	1 50	30	1 13		
7 36	6 53	9 36	5 32	11 36	4 38	16 0	3 25	21 0	2 37	31 0	1 50	52 0	1 12		
38	6 51	38	5 31	38	4 37	5	3 24	10	2 36	10	1 49	30	1 12		
40	6 49	40	5 30	40	4 37	10	3 23	20	2 35	20	1 49	53 0	1 11		
42	6 48	42	5 29	42	4 36	15	3 22	30	2 34	30	1 48	30	1 11		
44	6 46	44	5 28	44	4 35	20	3 21	40	2 33	40	1 48	54 0	1 10		
46	6 44	46	5 27	46	4 34	25	3 20	50	2 32	50	1 47	30	1 10		
7 48	6 43	9 48	5 26	11 48	4 34	16 30	3 19	22 0	2 31	32 0	1 47	55 0	1 10		
50	6 41	50	5 25	50	4 33	35	3 18	10	2 30	10	1 46	56 0	1 9		
52	6 40	52	5 24	52	4 32	40	3 17	20	2 29	20	1 46	57 0	1 8		
54	6 38	54	5 23	54	4 31	45	3 16	30	2 28	30	1 45	58 0	1 7		
56	6 37	56	5 22	56	4 31	50	3 15	40	2 27	40	1 45	59 0	1 6		
58	6 35	58	5 21	58	4 30	55	3 14	50	2 26	50	1 44	60 0	1 6		

TABLE XXVI.

REDUCTION of ☽'s Hor. Par.

Lat.	Red.
0°	0″
4	0
8	0
12	1
16	1
20	2
24	2
28	3
32	4
36	5
40	6
44	7
48	8
52	9
56	10
60	11
64	12
68	13
72	13
76	14
80	14
84	15
90	15

TABLE XXVII.—LUNI-SOLAR EQUATION.

ADD
For seconds of Moon's Horizontal Parallax.
Luni-Solar Equation.

☽'s Alt.	Add.	☽'s App. Alt.	Minutes of Moon's Horizontal Parallax. 53′	54′	55′	56′	57′	58′	59′	60′	61′
Alt.	Add.	° ′	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
		20° 0	16 34	16 55	17 16	17 38	17 59	18 20	18 42	19 3	19 24
		10	16 42	17 4	17 25	17 47	18 8	18 30	18 51	19 13	19 34
′	″	20	16 51	17 13	17 34	17 56	18 18	18 39	19 1	19 23	19 44
1	1	30	17 0	17 21	17 43	18 5	18 27	18 49	19 11	19 32	19 54
2	2	40	17 8	17 30	17 52	18 14	18 36	18 58	19 20	19 42	20 4
3	3	50	17 17	17 39	18 1	18 23	18 45	19 7	19 30	19 52	20 14
4	4										
5	5	21 0	17 25	17 48	18 10	18 32	18 55	19 17	19 39	20 2	20 24
6	6	10	17 34	17 56	18 19	18 41	19 4	19 26	19 49	20 11	20 34
7	7	20	17 43	18 5	18 28	18 51	19 13	19 36	19 58	20 21	20 44
8	7	30	17 51	18 14	18 37	19 0	19 22	19 45	20 8	20 31	20 54
9	8	40	18 0	18 23	18 46	19 9	19 32	19 55	20 18	20 41	21 4
		50	18 8	18 32	18 55	19 18	19 41	20 4	20 27	20 50	21 14
Alt.	Add.	22 0	18 17	18 40	19 4	19 27	19 50	20 14	20 37	21 0	21 24
′	″	10	18 26	18 49	19 12	19 36	19 59	20 23	20 46	21 10	21 33
1	1	20	18 34	18 58	19 21	19 45	20 8	20 32	20 56	21 19	21 43
2	2	30	18 43	19 6	19 30	19 54	20 18	20 41	21 5	21 29	21 53
3	3	40	18 51	19 15	19 39	20 3	20 27	20 51	21 15	21 39	22 3
4	4	50	18 59	19 23	19 48	20 12	20 36	21 0	21 24	21 48	22 12
5	5	23 0	19 8	19 32	19 56	20 21	20 45	21 9	21 33	21 58	22 22
6	6	10	19 16	19 41	20 5	20 29	20 54	21 18	21 43	22 7	22 32
7	6	20	19 25	19 49	20 14	20 38	21 3	21 28	21 52	22 17	22 41
8	7	30	19 33	19 58	20 23	20 47	21 12	21 37	22 2	22 26	22 51
9	8	40	19 42	20 6	20 31	20 56	21 21	21 46	22 11	22 36	23 1
		50	19 50	20 15	20 40	21 5	21 30	21 55	22 20	22 45	23 10
Alt.	Add.	24 0	19 59	20 24	20 49	21 14	21 39	22 4	22 30	22 55	23 20
′	″	10	20 7	20 32	20 57	21 23	21 48	22 14	22 39	23 4	23 30
1	1	20	20 15	20 41	21 6	21 32	21 57	22 23	22 48	23 14	23 39
2	2	30	20 24	20 49	21 15	21 41	22 6	22 32	22 58	23 23	23 49
3	3	40	20 32	20 58	21 24	21 49	22 15	22 41	23 7	23 33	23 59
4	4	50	20 40	21 6	21 32	21 58	22 24	22 50	23 16	23 42	24 8
5	5	25 0	20 49	21 15	21 41	22 7	22 33	23 0	23 26	23 52	24 18
6	5	10	20 57	21 23	21 50	22 16	22 42	23 9	23 35	24 1	24 28
7	6	20	21 6	21 32	21 58	22 25	22 51	23 18	23 44	24 11	24 37
8	7	30	21 14	21 40	22 7	22 34	23 0	23 27	23 54	24 20	24 47
9	8	40	21 22	21 49	22 16	22 43	23 9	23 36	24 3	24 30	24 56
		50	21 31	21 57	22 24	22 51	23 18	23 45	24 12	24 39	25 6
Alt.	Add.	26 0	21 39	22 6	22 33	23 0	23 27	23 54	24 22	24 49	25 16
′	″	10	21 47	22 14	22 42	23 9	23 36	24 3	24 31	24 58	25 25
1	1	20	21 55	22 23	22 50	23 18	23 45	24 12	24 40	25 7	25 35
2	2	30	22 4	22 31	22 59	23 26	23 54	24 21	24 49	25 17	25 44
3	3	40	22 12	22 40	23 7	23 35	24 3	24 30	24 58	25 26	25 54
4	4	50	22 20	22 48	23 16	23 44	24 12	24 39	25 7	25 35	26 3
5	4	27 0	22 29	22 57	23 24	23 52	24 20	24 48	25 16	25 44	26 12
6	5	10	22 37	23 5	23 33	24 1	24 29	24 57	25 25	25 54	26 22
7	6	20	22 45	23 13	23 41	24 10	24 38	25 6	25 34	26 3	26 31
8	7	30	22 53	23 21	23 50	24 18	24 47	25 15	25 44	26 12	26 41
9	8	40	23 1	23 30	23 58	24 27	24 55	25 24	25 53	26 21	26 50
		50	23 9	23 38	24 6	24 35	25 4	25 33	26 2	26 30	26 59
Alt.	Add.	28 0	23 17	23 46	24 15	24 44	25 13	25 42	26 11	26 40	27 9
′	″	10	23 25	23 54	24 23	24 52	25 21	25 51	26 20	26 49	27 18
1	1	20	23 33	24 3	24 32	25 1	25 30	25 59	26 29	26 58	27 27
2	2	30	23 42	24 11	24 40	25 10	25 39	26 8	26 38	27 7	27 37
3	3	40	23 50	24 19	24 49	25 18	25 48	26 17	26 47	27 16	27 46
4	3	50	23 58	24 28	24 57	25 27	25 56	26 26	26 56	27 26	27 55
5	4	29 0	24 6	24 36	25 6	25 35	26 5	26 35	27 5	27 35	28 5
6	5	10	24 14	24 44	25 14	25 44	26 14	26 44	27 14	27 44	28 14
7	6	20	24 22	24 52	25 22	25 52	26 22	26 53	27 23	27 53	28 23
8	7	30	24 30	25 0	25 30	26 1	26 31	27 1	27 32	28 2	28 32
9	8	40	24 38	25 8	25 39	26 9	26 40	27 10	27 40	28 11	28 41
		50	24 46	25 16	25 47	26 18	26 48	27 19	27 49	28 20	28 51

☽'s Alt.	Add.	Par.	Moon's Altitude. 20°	21°	22°	23°	24°	25°	26°	27°	28°	29°
		″	″	″	″	″	″	″	″	″	″	″
		1	0	0	0	0	0	0	0	0	0	0
		2	1	1	1	1	1	1	1	1	1	1
		3	1	1	1	1	1	1	1	1	1	1
		4	1	2	2	2	2	2	2	2	2	2
		5	2	2	2	2	2	2	2	2	2	2
		6	2	2	2	2	3	3	3	3	3	3
		7	2	3	3	3	3	3	3	3	3	3
		8	3	3	3	3	3	4	4	4	4	4
		9	3	3	3	4	4	4	4	4	4	4
		10	3	4	4	4	4	5	5	5	5	5
		11	4	4	4	4	5	5	5	5	5	5
		12	4	4	5	5	5	5	5	6	6	6
Alt.	Add.	13	5	5	5	5	5	6	6	6	6	6
′	″	14	5	5	5	6	6	6	6	7	7	7
1	1	15	5	5	6	6	6	6	7	7	7	7
2	2	16	6	6	6	6	7	7	7	7	8	8
3	3	17	6	6	7	7	7	7	8	8	8	8
4	4	18	6	7	7	7	7	8	8	8	9	9
5	5	19	7	7	8	8	8	8	9	9	9	9
6	6	20	7	7	8	8	8	9	9	9	10	10
7	6	21	7	7	8	8	9	9	9	10	10	10
8	7	22	8	8	9	9	9	10	10	10	11	11
9	8	23	8	8	9	9	10	10	10	11	11	11
		24	8	9	9	10	10	10	11	11	12	12
Alt.	Add.	25	9	9	10	10	10	11	11	12	12	12
′	″	26	9	10	10	10	11	11	12	12	13	13
1	1	27	9	10	10	11	11	12	12	13	13	13
2	2	28	9	10	11	11	12	12	13	13	14	14
3	3	29	10	11	11	12	12	13	13	14	14	14
4	4	30	10	11	11	12	12	13	14	14	14	15
5	5	31	11	11	12	12	13	13	14	14	15	15
6	5	32	11	12	12	13	13	14	14	15	15	16
7	6	33	12	12	13	13	14	14	15	15	16	16
8	7	34	12	12	13	14	14	15	15	16	16	17
9	8	35	12	13	14	14	15	15	16	16	17	17
		36	12	13	14	14	15	16	16	17	17	18
Alt.	Add.	37	13	14	14	15	15	16	17	17	18	18
′	″	38	13	14	15	15	16	16	17	18	18	19
1	1	39	14	14	15	16	16	17	18	18	19	19
2	2	40	14	15	16	16	17	17	18	19	19	20
3	3	41	14	15	16	16	17	18	18	19	20	20
4	4	42	15	15	16	17	17	18	19	20	20	21
5	4	43	15	16	16	17	18	19	19	20	21	21
6	5	44	15	16	17	18	18	19	20	21	21	22
7	6	45	16	16	17	18	19	19	20	21	22	22
8	7	46	16	17	18	18	19	20	21	21	22	23
9	8	47	16	17	18	19	20	20	21	22	23	23
		48	17	18	18	19	20	21	22	22	23	24
Alt.	Add.	49	17	18	19	20	20	21	22	23	24	24
′	″	50	17	18	19	20	21	22	23	23	24	25
1	1	51	18	19	20	20	21	22	23	24	25	25
2	2	52	18	19	20	21	22	23	23	24	25	26
3	3	53	19	19	20	21	22	23	24	25	26	26
4	3	54	19	20	21	22	22	23	24	25	26	27
5	4	55	19	20	21	22	23	24	25	26	27	27
6	5	56	20	21	21	22	23	24	25	26	27	28
7	6	57	20	21	22	23	24	25	26	27	28	28
8	7	58	20	21	22	23	24	25	26	27	28	29
9	8	59	21	22	23	24	25	26	27	28	29	29
		60	21	22	23	24	25	26	27	28	29	30

☉'s Alt. 6° 7° 8° 9° 10° 15° 20° 30° 40° 50° 60° 70° 80° 90°
Add 5″ 4″ 4″ 3″ 3″ 3″ 4″ 5″ 6″ 7″ 8″ 8″ 9″ 9″

☽'s Alt. 6° 7° 8° 9° 10° 15° 20° 30° 40° 50° 60° 70° 80° 90°
Add 4″ 3″ 2″ 2″ 2″ 1″ 1″ 0″ 0″ 0″ 0″

TABLE XXVIII.

Natural Numbers corresponding to the Auxiliary Arcs.

Auxiliary Arc E.								Auxiliary Arc W.							
Arc.	Nat. No.	Arc.	Nat. No.	Arc.	Nat. No.	Arc.	P. P.	Arc.	Nat. No.	Arc.	Nat. No.	Arc.	Nat. No.	Arc.	P. P.
′		′		′		″		′		′		′		″	
2° 0	34907	1° 0	17453	0° 0	00000	0	0	2° 0	64093	1° 0	81547	0° 0	99000	0	1000
1	35197	1	17744	1	00291	1	5	1	63803	1	81256	1	98709	1	995
2	35488	2	18035	2	00582	2	10	2	63512	2	80965	2	98418	2	990
3	35779	3	18326	3	00873	3	15	3	63221	3	80674	3	98127	3	985
4	36070	4	18617	4	01164	4	19	4	62930	4	80383	4	97836	4	981
5	36361	5	18908	5	01454	5	24	5	62639	5	80092	5	97546	5	976
6	36652	6	19199	6	01745	6	29	6	62348	6	79801	6	97255	6	971
7	36943	7	19489	7	02036	7	34	7	62057	7	79511	7	96964	7	966
8	37234	8	19780	8	02327	8	39	8	61766	8	79220	8	96673	8	961
9	37525	9	20071	9	02618	9	44	9	61475	9	78929	9	96382	9	956
2 10	37815	1 10	20362	0 10	02909	10	48	2 10	61185	1 10	78638	0 10	96091	10	952
11	38106	11	20653	11	03200	11	53	11	60894	11	78347	11	95800	11	947
12	38397	12	20944	12	03491	12	58	12	60603	12	78056	12	95509	12	942
13	38688	13	21235	13	03781	13	63	13	60312	13	77765	13	95219	13	937
14	38979	14	21526	14	04072	14	68	14	60021	14	77474	14	94928	14	932
15	39270	15	21817	15	04363	15	73	15	59730	15	77183	15	94637	15	927
16	39561	16	22107	16	04654	16	78	16	59439	16	77893	16	94346	16	922
17	39852	17	22398	17	04945	17	82	17	59138	17	77602	17	94055	17	918
18	40143	18	22689	18	05236	18	87	18	58857	18	77311	18	93764	18	913
19	40433	19	22980	19	05527	19	92	19	58567	19	76020	19	93473	19	908
2 20	40724	1 20	23271	0 20	05818	20	97	2 20	58276	1 20	75729	0 20	93182	20	903
21	41015	21	23562	21	01609	21	102	21	57985	21	75438	21	92891	21	898
22	41306	22	23853	22	06400	22	107	22	57694	22	75147	22	92600	22	893
23	41597	23	24144	23	06690	23	112	23	57403	23	74856	23	92310	23	888
24	41888	24	24435	24	06981	24	116	24	57112	24	74565	24	92019	24	884
25	42179	25	24725	25	07272	25	121	25	56821	25	74275	25	91728	25	879
26	42470	26	25016	26	07563	26	126	26	56530	26	73984	26	91437	26	874
27	42761	27	25307	27	07854	27	131	27	56239	27	73693	27	91146	27	869
28	43051	28	25598	28	08145	28	136	28	55949	28	73402	28	90855	28	864
29	43342	29	25889	29	08436	29	141	29	55658	29	73111	29	90564	29	859
2 30	43633	1 30	26180	0 30	08727	30	145	2 30	55367	1 30	72820	0 30	90273	30	855
31	43924	31	26471	31	09017	31	150	31	55076	31	72529	31	89983	31	850
32	44215	32	26762	32	09308	32	155	32	54785	32	72238	32	89692	32	845
33	44506	33	27053	33	09599	33	160	33	54494	33	71947	33	89401	33	840
34	44797	34	27343	34	09890	34	165	34	54203	34	71657	34	88110	34	835
35	45088	35	27634	35	10181	35	170	35	53912	35	71366	35	88819	35	830
36	45379	36	27925	36	10472	36	175	36	53621	36	71075	36	88528	36	825
37	45669	37	28216	37	10763	37	179	37	53331	37	70784	37	88237	37	821
38	45960	38	28507	38	11054	38	184	38	53040	38	70493	38	87946	38	816
39	46251	39	28798	39	11345	39	189	39	52749	39	70202	39	87655	39	811
2 40	46542	1 40	29089	0 40	11635	40	194	2 40	52458	1 40	69911	0 40	87365	40	806
41	46833	41	29380	41	11926	41	199	41	52167	41	69620	41	87074	41	801
42	47124	42	29671	42	12217	42	204	42	51876	42	69329	42	86783	42	796
43	47415	43	29961	43	12508	43	208	43	51585	43	69039	43	86492	43	792
44	47706	44	30252	44	12799	44	213	44	51294	44	68748	44	86201	44	787
45	47997	45	30543	45	13090	45	218	45	51003	45	68457	45	85910	45	782
46	48287	46	30834	46	13381	46	223	46	50713	46	68166	46	85619	46	777
47	48578	47	31125	47	13672	47	228	47	50422	47	67875	47	85328	47	772
48	48869	48	31416	48	13963	48	233	48	50131	48	67584	48	85037	48	767
49	49160	49	31707	49	14253	49	238	49	49840	49	67293	49	84747	49	762
2 50	49451	1 50	31998	0 50	14544	50	242	2 50	49549	1 50	67002	0 50	84456	50	758
51	49742	51	32289	51	14835	51	247	51	49258	51	66711	51	84165	51	753
52	50033	52	32579	52	15126	52	252	52	48967	52	66421	52	83874	52	748
53	50324	53	32870	53	15417	53	257	53	48676	53	66130	53	83583	53	743
54	50615	54	33161	54	15708	54	262	54	48385	54	65839	54	83292	54	738
55	50905	55	33452	55	15999	55	267	55	48095	55	65548	55	83001	55	733
56	51196	56	33743	56	16290	56	271	56	47804	56	65257	56	82710	56	729
57	51487	57	34034	57	16581	57	276	57	47513	57	64966	57	82419	57	724
58	51778	58	34325	58	16871	58	281	58	47222	58	64675	58	82129	58	719
59	52069	59	34616	59	17162	59	286	59	46931	59	64384	59	81838	59	714

APPENDIX.

APPENDIX.

I.

ADDITIONAL LUNAR METHODS.

SOME of the Methods here given are not complete, as far as regards the Tables: this may be afterwards remedied, should it appear that they are approved of.

Method II. is somewhat similar to Method I., which has been already given: the special Tables, however required in this Method, are the simplest of any, and the solution is easy.

Method III. requires a Table of an Auxiliary Arc, which is contained in Several Treatises on Navigation; it is TABLE XXX.* in NORIE'S NAVIGATION. It also requires a Table of *Natural Versed Sines*, being Table XXXVI. in NORIE'S NAVIGATION.

Method IV. requires a Table, containing what is called the Luni-Solar Equation: a specimen of the Table is given, for Altitudes of the Moon from 20° to 30°. It also requires a Table of *Natural Versed Sines*.

Method V. requires Tables of the Luni-Solar Equation, and *Natural Versed Sines*, as in Method IV. It also requires Tables of the Corrections in Altitude of the Moon and Sun (Star, or Planet), these being the differences betwixt the Parallaxes and Refractions at the given altitudes: found in Table XXX. of NORIE.

Method II., as here given, may, therefore, be applied in all cases; so also may Method III., with the assistance of the Tables of the *Auxiliary Arc* referred to, and a Table of *Natural Versed Sines*. The Tables in Method III. might be easily changed so as to avoid the use of the terms E and W, as the auxiliary arcs might be made always additive.

METHOD II.

1. Find the apparent Altitudes and Distance, as in Method I.

2. Find the *Moon's Departure in Altitude*, from Table XXII.; and take the *Correction* corresponding to this Departure from Table VIII. Find the *Star's Correction*, from Table XXIV. And, if the Sun or a Planet has been observed, find the *Correction for Parallax*, from Table VII., as in Method I.

   Add these *Corrections* to the Apparent Distance, the sum is the *Corrected Distance*.

3. Find the *Equation of Altitude*, corresponding to the Moon's apparent altitude, from Table XXV.; and subtract it from the Moon's Horizontal Parallax: the remainder is the *first Auxiliary Arc.*

From the *first Auxiliary Arc*, subtract the Equation of Altitude, already found: the remainder is the *third Auxiliary Arc.*

Find the *Equation of Altitude*, corresponding to the apparent altitude of the Sun, Star, or Planet: this is the *second* Auxiliary Arc.

The 1st *Auxiliary Arc* is always *West:* the 2d *Auxiliary Arc* is always *East:* and the 3d *Auxiliary Arc* is *East*, when the Distance is *less than* 90°; but *West*, when the Distance is *greater than* 90°.

To find the Departure of Distance, and True Distance.

4. In the *first line:* write the *Logarithmic Sine* of the Apparent Distance, in the first and second columns; and its *Logarithmic Tangent*, in the third column: taken from Table IX.

In the *second line:* write the *Logarithmic Cosecant* of the apparent altitude of the Sun, Star, or Planet, in the first column; and the *Logarithmic Cosecant* of the Moon's apparent altitude, in the second and third columns: taken from Table IX.

In the *third line:* write the *Proportional Logarithms* (Table X.), of the *three Auxiliary Arcs.*

5. Add the columns thus formed, rejecting 10 from all the indexes, when possible: this gives the *Proportional Logarithms* of the *first, second,* and *third Departures;* which are, respectively, of the same names as the *Auxiliary Arcs.*

6. Find the amount of the *three Departures*, attending to their names, as in Method I. This gives the *Departure of Distance*, which is to be corrected, by Table VIII. (the *correction* being always *West*), and applied to the *Corrected Distance*, as in Method I.: viz., by *adding* it, when *East;* but subtracting it when *West.* The result thus found is the *True Distance.*

EXAMPLE I.: See Method I., Example I.

Star's apparent altitude,	48° 16′		Moon's Horizontal Parallax,		56′ 30″
Moon's apparent altitude,	26° 23′		Moon's Equation of altitude, Table XXV.,		2 8
Moon's Horizontal Parallax,	56′ 30″		1st *Auxiliary Arc*,		54 22 W
Apparent Distance,	99° 33′ 14″		Moon's Equation of altitude,		2 8
☽'s *Departure*, Table XXII. = 48′, gives *Correction*, Table VIII.,	+ 17		3d *Auxiliary Arc*,		52 14 W
Star's *Correction*, Table XXIV.,	+ 0		Star's Equation of altitude, Table XXV., = 2d *Auxiliary Arc*,		1 16 E
Corrected Distance,	99 33 31	Sine 9.9939	Sine 9.9939		Tang. 7741
		Star's alt. Cosec. 1271	☽'s alt. Cosec. 3523		Cosec. 3523
		Auxiliary Arcs, P. Logs. 5199	P. Log. 2.1526		P. Log. 5373
		P. Log. 6409	P. Log. 2.4988		P. Log. 1.6637
		1st *Departure*,	41′ 9″ W	2d *Dep.* 0′ 34″ E	3d *Dep.* 3′ 54″ W
		3d,	3 54 W		
			45 3 W		
		2d,	0 34 E		
		Departure of Distance,	44 29 W		
		Correction for Dep. 44′, Table VIII.,	17 W		
			44 46 W		
		Corrected Distance,	99 33 31		
		True Distance,	98 48 45		

EXAMPLE II.: See Method I., Example II.

Sun's apparent altitude,	32° 59′			Moon's Horizontal Parallax,		57′ 20″		
Moon's apparent altitude,	65° 35′			Moon's Equation of altitude, Table XXV.,		−1 2		
Moon's Horizontal Parallax,	57′ 20″							
Apparent Distance,	79° 59′ 54″			1st *Auxiliary arc*,		56 18	W	
☽'s *Departure*, Table XXII. = 23′, gives *Correction*, Table VIII.,	+ 21			Moon's Equation of altitude,		1 2		
				3d *Auxiliary Arc*,		55 16	E	
Star's *Correction*, Table XXIV.,	+ 0			Sun's Equation of altitude, Table XXV., = 2d *Auxiliary Arc*,		1 44	E	
Sun's *Correction*, Table VII.,	+ 2							
Corrected Distance,	80 0 17	Sine	9.9934	Sine	9.9934	Tang.	7537	
		Sun's altitude, Cosec.	2641	☽'s alt. Cosec.	0407	Cosec.	0407	
		Auxiliary Arcs, P. Log.	5048	P. Log.	2.0164	P. Log.	5128	
		P. Log.	7623	P. Log.	2.0505	P. Log.	1.3072	
		1st *Departure*,	31′ 7″ W	2d *Dep.*	1′ 36″ E	3d *Dep.*	8′ 52″ E	
			10 28 E					
Departure of Distance,			20 39 W					
10″ + *Correction* for Dep. 21′, Table VIII.,			31 W					
			21 10 W					
Corrected Distance,		80	0 17					
True Distance,		79	39 7					

METHOD III.

1. Find, from Table XXV., the Equations of altitude of the Moon and Sun (Star, or Planet). The differences between these, and the Horizontal Parallaxes are the *first* and *second Auxiliary Arcs*.

2. Find, from Table IX., the *Logarithmic Cosecants* of the apparent altitudes of the Moon and Sun, (Star, or Planet). To these add respectively the *Proportional Logarithms* (Table X.), of the two *Auxiliary Arcs*, rejecting 10 from the indexes, when possible.

   These sums are the *Proportional Logarithms* of the *first* and *second Departures of Distance*: the *second*, however, must be corrected by Table XXIII.

   The 1st *Departure of Distance* is always *West*; and the *second* is always *East*.

3. Take the difference of the *two Departures*, which will be of the same name as the greater.

4. Find the *Auxiliary Arc*, from Table XXX.* of Norie's Navigation, and take the *sum* and *difference* of it, and the apparent Distance.

5. Add together the *Versed Sines* of this *sum* and *difference*, (found from Table XXXVI. of Norie's Navigation), and the *Natural Number*, from Table XXVIII., corresponding to the difference between the *Departures of Distance*, (found by the second part of this Rule); the sum will be the *Versed Sine* of the *True Distance*.

Note. In this operation, the last five figures only of the Versed Sines are retained, these being quite sufficient for determining the true distance, as it never differs much more than 1° from the apparent distance, and it must therefore be found in the same page of the Table with the apparent distance, or either in the preceding or following page.

EXAMPLE: See Method I., Example II.

Moon's Horizontal Parallax, 57′ 20″, ☽'s apparent altitude, 65° 35′; ☉'s apparent altitude, 32 59, Apparent distance, 79° 59′ 54″

Horizontal Parallax of ☽ 57′ 20″ ... of ☉ 0′ 9″

Equation of altitude, Table XXV., of ☽ 1 2 ... of ☉ 1 44

Auxiliary Arcs, 1st 56 18 2d 1 35 — Aux. Arc. (from Norie, Table XXX.*) 60° 28′ 51″ + 10 + 3

☉'s alt. Cosec. 2641 ☽'s alt. Cosec. 0407 60 29 4 Diff. of Departures =

Aux. Arcs, P. Log. 5048 P. Log. 2.0557 App. dist. 79 59 54 29′ 13″ W, Nat. No. 90564 P.P. 937

P. Log. 7689 P. Log. 2.0964 Sum 140 28 58 Versed Sine, 71254 ... 180

1st Departure, 30′ 39″ W 2d, 1′ 26″ E Diff. 19 50 50 Versed Sine, 57358 ... 82

2d Departure, 1 26 E *Cor.*, Table XXIII., +0 1199 ... 1199

Diff. of Departures, 29 13 W 1 26 E True distance = 79° 39′ 8″ Versed Sine, 20375

339

36

METHOD IV.

1. Find the *first* and *second Departures of Distance*, as in Method III.

2. Find, from Table XXVII., the Luni-Solar Equation, or *third Auxiliary Arc*; to the *Proportional Logarithm* of which, add the *Logarithmic Secant* of the Apparent Distance: the sum is the *Proportional Logarithm* of the *third Departure of Distance*, which is *East* when the Distance is less than 90°, but *West* when the Distance is *greater than* 90°.

Note. In performing this calculation, all the three Auxiliary should be first found, and then the Logarithms as directed in the Rule. A *Logarithmic Secant* is the same as the *Logarithmic Cosecant* of the *Complement*, which is found by Table IX.

3. Find the amount of the *three Departures*, attending to their names, as in Method I.; and add the *Natural Number* corresponding to this amount, from Table XXVIII., to the *Versed Sine* of the Apparent Distance: the sum is the *Versed Sine* of the *True Distance*.

Note. The Versed Sines are limited to the last five figures, as in Method III.

EXAMPLE: See Method I., Example I.

Moon's Horizontal Parallax, 56′ 30″, ☽'s apparent altitude, 26° 23′; ✳'s apparent altitude, 48 16; Apparent Distance, 99° 33′ 14″

Luni-Solar Equation, Table XXVII. 23′ 21″

Horizontal Parallax of ☽,			56′ 30″	... of ✳	0′ 0″		+ 14	
Equation of altitude, Table XXV., of ☽,			2 8	... of ✳	1 16		+ 0	
Auxiliary Arcs,		1st,	54 22	2d,	1 16	3d,	23 35	
✳'s alt. Cosec.	1271	☽'s alt. Cosec.	3523	Dist. Sec.	7801			
Aux. Arcs, P. Log.	5199	P. Log.	2.1526	P. Log.	8827			
P. Log.	6470	P. Log.	2.5049	P. Log.	1.6628			
Departures of Distance, 1st,	40′ 35″ W	2d,	0′ 34″ E	3d,	3′ 55″ W			
Cor., Table XXIII.,		+ 0		1st,	40 35 W			
		0 34 E			44 30 W			
				2d,	0 34 E			
		Amount of Departures,		43 56 W		Natural No.	86492	P.P. 729
		Apparent Distance,	99° 33′ 14″			Versed Sine,	65908	 67
							796	 796
		True Distance,	98 48 44			Versed Sine,	53196	
							2986	
							210	

METHOD V.

1. To the *sum of the Apparent altitudes* of the Moon and Sun, (Star, or Planet), add the *Moon's Correction*, from Table XXX. of NORIE'S Navigation; and, from the result subtract the *Star's Correction:* the remainder is the sum of the True altitudes. Subtract this sum from 180°, the result is the *sum of the True Zenith Distances.*

   Note. The *Star's Correction* is the *Refraction;* but in the case of the Sun, or a Planet, this must be diminished by the *Parallax* at the given altitude, Table III.

2. Find the *Logarithmic Secant* of the *sum of the Apparent Altitudes,* and the *Logarithmic Secant* of the *Apparent Distance,* rejecting 10 from the index of each: and add to these the *Proportional Logarithms* (Table X.), of the *Luni-Solar Equation,* from Table XXVII., the sums will be the *Proportional Logarithms* of the *first* and *second Departures of Distance.*

   The *Departures* are both *East,* if the *Apparent Distance* and the sum of the Apparent Altitudes are each *less than* 90°; but, if either of these be *greater than* 90°, the corresponding Departure is *West.*

5. Find the amount of the *two Departures,* attending to their names, as in Method I.

6. Add together, the *Natural Number,* from Table XXVIII., corresponding to the *amount of the Departures,* and the *Versed Sines* of the sum of the *apparent* altitudes, the sum of the *true* Zenith distances, and the *Apparent* distance: the result is the *Versed Sine* of the *True Distance.*

   Note. The Versed Sines are limited to the last five figures, as in Methods III. and IV. Instead of taking the Versed Sine of the sum of the true *Zenith distances,* we may take the *Suversed Sine* of the sum of the true *altitudes,*

It may be observed, that the sum of the *apparent altitudes* is always found, in the Table of Versed Sines, near the sum of the *true altitudes*, or the sum of the *true Zenith distances*; and the same is the case with the *apparent* and *true* distances: consequently, the Table of Versed Sines requires to be opened only twice. The *Logarithmic Secants* may be found from Table IX., by taking the *Cosecants* of the *Complements*: this trouble might have been avoided by having the Complements of the degrees at the top, printed at the bottom, with the titles *Cosine*, *Cotangent* and *Secant*.

EXAMPLE: See Method I., Example I.

Moon's Horizontal Parallax, 56′ 30″, ☽'s apparent altitude, 26° 23′ / ✱'s apparent altitude, 48 16, Apparent Distance, 99° 33′ 14″

☽'s App. Alt.	26°	23′			Sum of App. Alts. Sec.	5772	App. Dist. Sec.	7801	
✱'s App. Alt.	48	16			Luni-Solar Eq. P. Log.	8827	P. Log.	8827	
Sum of App. Alts.	74	39	Luni-Solar Equation,		P. Log.	1.4599	P. Log.	1.6628	
☽'s Correction,	+ 48	16	23	21	*Departures* of Dist. 1st,	6′ 15″ E	2d,	3′ 55″ W	
		27		14	2d,	3 55 W			
	75	27	43	0		2 20 E	Nat No.	00582	PP. 97
✱'s Correction,	— 0	51	23	35	Sum of App. Alts. Versed Sine,		35285	...	0
Sum of True Alts.	75	26	52		Sum of True Zen. Dists. Versed Sine,		51225	...	37
	180	0	0		Apparent Distance, Versed Sine,		65908	...	67
Sum of True Zen. Dists.	104	33	8				201	...	201
					True Distance, 98° 48′ 45″ Versed Sine,		53201		
							2986		
							215		

APPENDIX.

II.

DEMONSTRATIONS

OF THE

RULES FOR THE LUNAR METHODS.

Let A = Apparent altitude of moon.

A' = True altitude of moon.

a = Correction of moon's altitude.

R = Refraction of the moon in altitude.

P = Parallax of moon in altitude.

H = Horizontal parallax of moon.

B = Apparent altitude of star, which may be the sun, a fixed star, or a planet.

B' = True altitude of star.

β = Correction of star's altitude.

r = Refraction of star in altitude.

p = Parallax of star in altitude.

h = Horizontal parallax of star.

D = Apparent distance between moon and star.

D' = True distance between moon and star.

$\Delta = \frac{\cos A' \cos B'}{\cos A \cos B}$, see (12).

$\delta = 1 - \Delta$.

$\epsilon = 57'' - r \tan B$.

$\epsilon' = 57'' - R \tan A$.

M = Modulus of Brigg's System of Logarithms.

C = Correction of Distance = $D' - D$.

$c = a\beta . \frac{\cos (A + B) \cos (A - B)}{\cos A \cos B}$, see (36).

Z = Difference of the azimuths of moon and star.

x is found from $2 \cos (60° + x) = \Delta$, see IV.

$y = 60° + x$, see VIII.

I. INVESTIGATION OF FORMULA (*a*).

$$\text{Cos D} = \cos(\text{A} - \text{B}) - \text{vers Z} \cos \text{A} \cos \text{B}. \quad (1)$$

$$\text{Cos D}' = \cos(\text{A}' - \text{B}') - \text{vers Z} \cos \text{A}' \cos \text{B}'. \quad (2)$$

(1), multiplied by cos A′ cos B′, gives

$$\cos \text{D} \cos \text{A}' \cos \text{B}' = \cos(\text{A} - \text{B}) \cos \text{A}' \cos \text{B}' - \text{vers Z} \cos \text{A} \cos \text{B} \cos \text{A}' \cos \text{B}'. \quad (3)$$

And (2), multiplied by cos A cos B, gives

$$\cos \text{D}' \cos \text{A} \cos \text{B} = \cos(\text{A}' - \text{B}') \cos \text{A} \cos \text{B} - \text{vers Z} \cos \text{A} \cos \text{B} \cos \text{A}' \cos \text{B}'. \quad (4)$$

(4) — (3) gives, cos D′ cos A cos B — cos D cos A′ cos B′ =

$$\cos(\text{A}' - \text{B}') \cos \text{A} \cos \text{B} - \cos(\text{A} - \text{B}) \cos \text{A}' \cos \text{B}'. \quad (5)$$

But, if a and b be any two arcs, $\cos a \cos b = \frac{1}{2} \cos(a - b) + \frac{1}{2} \cos(a + b)$. (6)

Hence, if in (6), we make a and b = A and B, and then = A′ and B′,

(5) and (6) will give, cos D′ cos A cos B — cos D cos A′ cos B′ =

$$\tfrac{1}{2} \cos(\text{A}' - \text{B}') \cos(\text{A} + \text{B}) - \tfrac{1}{2} \cos(\text{A}' + \text{B}') \cos(\text{A} - \text{B}). \quad (7)$$

And, if in (6), we make a = A + B, and b = A′ − B′,

and then a = A′ + B′, and b = A − B,

(6) and (7) will give, cos D′ cos A cos B — cos D cos A′ cos B′ =

$$\tfrac{1}{4} \cos(\text{A} - \text{A}' + \text{B} + \text{B}') + \tfrac{1}{4} \cos(\text{A} + \text{A}' + \text{B} - \text{B}')$$
$$- \tfrac{1}{4} \cos(\text{A}' - \text{A} + \text{B}' + \text{B}) - \tfrac{1}{4} \cos(\text{A} + \text{A} + \text{B}' - \text{B}). \quad (8)$$

But, if a and b be any two arcs,

$$\sin a \sin b = \tfrac{1}{2} \cos(a - b) - \tfrac{1}{2} \cos(a + b) \quad (9)$$

And, if in (9), we make a = A′ + A, and b = B′ − B,

and then a = B + B′, and b = A′ − A,

(8) and (9) will give, cos D′ cos A cos B — cos D cos A′ cos B′ =

$$\tfrac{1}{2} \sin(\text{A}' + \text{A}) \sin(\text{B}' - \text{B}) + \tfrac{1}{2} \sin(\text{A}' - \text{A}) \sin(\text{B} + \text{B}'). \quad (10)$$

But A′ = A + α, and B′ = B − β: hence by substitution in (9),

we have cos D′ cos A cos B — cos D cos A′ cos B′ =

$$\tfrac{1}{2} \sin(2\,\text{A} + \alpha) \sin(-\beta) + \tfrac{1}{2} \sin(2\,\text{B} - \beta) \sin \alpha.$$

But α and β being small arcs, we may assume $\sin \alpha = \alpha$, and $\sin(-\beta) = -\beta$.

Hence, cos D′ cos A cos B — cos D cos A′ cos B′ =

$$-\tfrac{1}{2} \beta \sin(2\,\text{A} + \alpha) + \tfrac{1}{2} \alpha \sin(2\,\text{B} - \beta) \quad (11)$$

Let $\Delta = \dfrac{\cos \text{A}' \cos \text{B}'}{\cos \text{A} \cos \text{B}}$, and $\delta = 1 - \Delta = \dfrac{\cos \text{A} \cos \text{B} - \cos \text{A}' \cos \text{B}'}{\cos \text{A} \cos \text{B}}$

Hence, cos A cos B − cos A′ cos B′ = δ cos A cos B. (12)

(12) multiplied by cos D, gives cos D cos A cos B — cos D cos A′ cos B′ =

$$\delta \cos \text{D} \cos \text{A} \cos \text{B}. \quad (13)$$

(13) — (11), being divided by cos A cos B, gives

$$\cos \text{D} - \cos \text{D}' = \frac{\tfrac{1}{2} \beta \sin(2\,\text{A} + \alpha) - \tfrac{1}{2} \alpha \sin(2\,\text{B} - \beta)}{\cos \text{A} \cos \text{B}} + \delta \cos \text{D}. \quad \text{formula } (a)$$

II. CALCULATION OF LOG Δ: WHICH IS CALLED THE LOGARITHMIC DIFFERENCE.

Note. In what follows, quantities below the second order are rejected as being inconsiderable.

$$\text{Log } \Delta = \log \frac{\cos \text{A}' \cos \text{B}'}{\cos \text{A} \cos \text{B}} = \log \frac{\cos \text{A}'}{\cos \text{A}} + \log \frac{\cos \text{B}'}{\cos \text{B}}; \quad (14)$$

$$\text{But, } \cos \text{B}' = \text{Cos}(\text{B} - \beta) = \cos \text{B} \cos \beta + \sin \text{B} \sin \beta = \cos \text{B} \left(1 - \frac{\beta^2}{2}\right) + \beta \sin \text{B}.$$

$$\text{Hence, } \frac{\cos \text{B}'}{\cos \text{B}} = 1 - \frac{\beta^2}{2} + \beta \tan \text{B}. \quad (15)$$

If z be any number, $\log(1 + z) = \text{M}z - \frac{1}{2} \text{M}z^2 + \&\text{c.}$, therefore,

$$\log \frac{\cos \text{B}'}{\cos \text{B}} = \text{M}\beta \tan \text{B} - \tfrac{1}{2} \text{M}\beta^2 - \tfrac{1}{2} \text{M}\beta^2 \tan^2 \text{B}. \quad (16)$$

For altitudes not below 6°, r tan B is nearly = 57″, let r tan B = 57″ − ϵ,

hence, β tan B = ($r - p$) tan B = ($r - h$ cos B) tan B =

$$r \tan \text{B} - h \sin \text{B} = 57'' - \epsilon - h \sin \text{B}. \quad (17)$$

Therefore, the term $\frac{1}{2} M\beta^2 \tan^2 B$ may be neglected on account of its smallness,

and we have, $\log \frac{\cos B'}{\cos B} = M.57'' - M\varrho - Mh \sin B - \frac{1}{2} M\beta^2$,

If, therefore, we calculate $\frac{\cos A'}{\cos A}$, and increase it by M.57″, or 0.0001200,

we shall obtain an approximate value of log Δ, being the tabulated value contained in the common tables of the logarithmic difference. . . . . (18)

From the value of log Δ, in (18), we must subtract,

$M(\varrho + h \sin B + \frac{1}{2}\beta^2)$, for the sun or a planet, ... (19)

and $M(\varrho + \frac{1}{2} r^2)$, for a fixed star. . . . . (20)

III. CALCULATION OF ϑ, OMITTING QUANTITIES BELOW THE 2D ORDER.

$$\vartheta = 1 - \Delta = 1 - \frac{\cos A' \cos B'}{\cos A \cos B}. \quad . . . . . (21)$$

But, by (15), $\frac{\cos B'}{\cos B} = 1 - \frac{\beta^2}{2} + \beta \tan B$,

and, similarly, $\frac{\cos A'}{\cos A} = 1 - \frac{\alpha^2}{2} - \alpha \tan A$:

Hence, by multiplication, $\frac{\cos A' \cos B'}{\cos A \cos B} =$

$1 - \frac{1}{2}\alpha^2 - \frac{1}{2}\beta^2 - \alpha \tan A + \beta \tan B - \alpha\beta \tan A \tan B$. . . . . (22)

But, by (17), $\beta \tan B = 57'' - \varrho - h \sin B$,

and, similarly, $\alpha \tan A = H \sin A - 57'' + \varrho'$. . . . . (23)

From (21), (22) and (23), we have $\vartheta =$

$H \sin A - 114'' + \varrho' + \frac{1}{2}\alpha^2 + \alpha\beta \tan A \tan B + h \sin B + \varrho + \frac{1}{2}\beta^2$. . . . . (24)

(23) and (24) give $\alpha \tan A = \vartheta$, nearly; and, (23) gives $\beta \tan B = 57'' - h \sin B$, nearly:—

Hence, by multiplication, $\alpha\beta \tan A \tan B = \vartheta.57'' - \vartheta h \sin B$. . . . . (25)

The formula in (25) would cause some inconvenience in tabulating ϑ, but its value is in general so inconsiderable, that it may be safely neglected. It is greatest for a fixed star, being $= \vartheta.57''$, and this, at its maximum, amounts only to about 1″. We shall, therefore, make $\alpha\beta \tan A = \vartheta.57''$, as this will be practically correct for the sun or a fixed star.

We may, therefore, tabulate $\vartheta = H.\sin A - 114'' + \varrho' + \frac{1}{2}\alpha^2 + \vartheta.57''$. . . . . (26)

The correction to be added for the sun or a planet is $h.\sin B + \varrho + \frac{1}{2}\beta^2$, ... (27)

And the correction to be added for a fixed star is $\varrho + \frac{1}{2} r^2$. . . . . (28)

OTHERWISE.

By calculating Δ from the approximate value of log Δ given in (18), and subtracting the result from unity, we shall obtain the approximate value of $1 - \Delta$ or ϑ. . . . . (29)

To ascertain what the corrections, given in (19) and (20), become when applied to ϑ, we must ascertain what variation of ϑ is caused by a small variation of log Δ:

Now $\vartheta = 1 - \Delta$, therefore $d\vartheta = -d\Delta$; but $d\Delta = \frac{d \log \Delta . \Delta}{M}$,

therefore $d\vartheta = -\frac{d \log \Delta . \Delta}{M} = -\frac{d \log \Delta}{M} + \frac{d \log \Delta}{M} . \vartheta$. . . . . (30)

The corrections in (19) and (20) being small, we may omit the term $\frac{d \log \Delta}{M} . \vartheta$, which gives $d\vartheta = -\frac{d \log \Delta}{M}$; and, therefore, the corrections of ϑ are proportional to those of log Δ, taken with a contrary sign, and are, consequently, additive to ϑ. . . . . (31)

But, as stated in (18), a correction of M. $57''$ in log Δ is $= 0.0001200$, or to 120, if we extend log Δ only to 6 places of decimals, and neglect the ciphers on the left: and d log Δ = M. $57''$, gives $d\vartheta = -57''$ by (31).

Hence 120 : correction of log Δ : : $57''$: correction of ϑ.

This mode of calculating ϑ, and its corrections, will give the same results as in (26), (27), and (28):

For the number corresponding to log $\frac{\cos A'}{\cos A}$ is $\frac{\cos A'}{\cos A} =$

similarly as in (15), $1 - \frac{1}{2}\alpha^2 - \alpha \tan A =$
by (23), $1 - \frac{1}{2}\alpha^2 -$ H. sin A $+ 57'' - \epsilon'$.

Hence, if we take log $\Delta = \log \frac{\cos A'}{\cos A}$, we have $\Delta = \frac{\cos A'}{\cos A}$,

and $\vartheta = 1 - \Delta =$ H sin A $- 57'' + \epsilon + \frac{1}{2}\alpha^2$.

But to this value of log Δ, the correction M. $57''$ is applied in (18),
and, which by (30), gives the correction for $\vartheta = -57'' + \vartheta$. $57''$:
Hence, the approximate value of ϑ, as found by (29); is $=$
H sin A $- 114'' + \epsilon' + \frac{1}{2}\alpha^2 + \vartheta.57''$, which agrees exactly with formula in (26).

Again, by (31), $d\vartheta = -\frac{d \log \Delta}{M}$ hence, by substituting (19) and (20) for d. log Δ,

we have, the correction for the sun or a planet $= \epsilon + h \sin B + \frac{1}{2}\beta^2$,
and the correction for a fixed star $= \epsilon + \frac{1}{2}r^2$:
which formulas are the same as those in (27) and (28).

IV. CALCULATION OF x FROM THE EQUATION $2 \cos (60° + x) = \Delta$.

Since $2 \cos (60° + x) = \Delta$; and $\cos (60° + x) = \cos 60° \cos x - \sin 60° \sin x$,
we have $\Delta = 2 \cos 60° \cos x - 2 \sin 60° \sin x$.

But $2 \cos 60° = 1$; and as Δ is nearly $= 1$, x is a small arc, and therefore we may assume $\sin x = x$, and $\cos x = 1 - \frac{1}{2}x^2$:

Hence $\Delta = 1 - \frac{1}{2}x^2 - 2x \sin 60°$,
and $\vartheta = 1 - \Delta = \frac{1}{2}x^2 + 2x \sin 60°$.

Therefore $x = \frac{\vartheta - \frac{1}{2}x^2}{2 \sin 60°} = \frac{1}{2}\vartheta \operatorname{cosec} 60° - \frac{1}{4}x^2 \operatorname{cosec} 60° =$

$\frac{1}{2}\vartheta \operatorname{cosec} 60° - \frac{1}{4}(\frac{1}{2}\vartheta \operatorname{cosec} 60°)^2 . \operatorname{cosec} 60°$.

But the tabulated value of ϑ has been already given in (26), hence we may easily find the corresponding value of x.

In order to find the corrections of x for the sun, or a fixed star, or a planet,
we may assume $x = \frac{1}{2}\vartheta \operatorname{cosec} 60°$; but $\operatorname{cosec} 60° = \frac{4}{7}$ nearly, therefore $x = \frac{4}{7}\vartheta$,

and $dx = \frac{4}{7} d\vartheta$:

Hence, by multiplying the corrections of ϑ in (27) and (28) by $\frac{4}{7}$, we shall obtain the corresponding corrections of x.

Note. The value of x is contained in Table XXX.* of Norie's Navigation.

V. INVESTIGATION OF FORMULAS (b) and (b').

Formulas (b) and (b') are derived from formula (a) by rejecting quantities below the 2d order.

Formula (a) is $\cos D - \cos D' =$

$$\frac{\frac{1}{2}\beta \sin (2A + \alpha) - \frac{1}{2}\alpha \sin (2B - \beta)}{\cos A \cos B} + \vartheta \cos D \quad \ldots \quad (32)$$

But, $\sin (2A + \alpha) = \sin 2A \cos \alpha + \cos 2A \sin \alpha = \sin 2A + \alpha \cos 2A \quad \ldots \quad (33)$

and, $\sin (2B - \beta) = \sin 2B \cos \beta - \cos 2B \sin \beta = \sin 2B - \beta \cos 2B \quad \ldots \quad (34)$

(32), (33) and (34) give, cos D − cos D′ =

$$\frac{\frac{1}{2}\beta \sin 2A - \frac{1}{2}\alpha \sin 2B}{\cos A \cos B} + \delta \cos D + \frac{1}{2}\alpha\beta . \frac{\cos 2A + \cos 2B}{\cos A \cos B} \quad \ldots\ldots\ldots \quad (35)$$

$$\text{But, } \frac{1}{2}\alpha\beta . \frac{\cos 2A + \cos 2B}{\cos A \cos B} = \alpha\beta . \frac{\cos (A+B) \cos A - B}{\cos A \cos B}\text{; let this be denoted by } c. \quad (36)$$

$$\text{Also } \frac{\frac{1}{2} \sin 2A}{\cos A \cos B} = \frac{\sin A \cos A}{\cos A \cos B} = \frac{\sin A}{\cos B},$$

$$\text{and, similarly, } \frac{\frac{1}{2} \sin 2B}{\cos A \cos B} = \frac{\sin B}{\cos A} \quad \ldots\ldots\ldots\ldots \quad (37)$$

(35), (36), and (37) give, $\cos D - \cos D' = \frac{\beta}{\cos B} . \sin A - \frac{\alpha}{\cos A} . \sin B + \delta \cos D + c$. . . . . (38)

But, $\beta = r - p = r - h \cos B$; $\therefore \frac{\beta}{\cos B} = \frac{r}{\cos B} - h$; and, similarly, $\frac{\alpha}{\cos A} = H - \frac{R}{\cos B}$ . . (39)

(38) and (39) give, cos D − cos D′ =

$$\left(\frac{r}{\cos B} - h\right) \sin A - \left(H - \frac{R}{\cos B}\right) \sin B + \delta \cos D + c. \quad \ldots\ldots \text{ formula } (b)$$

Let this value of cos D − cos D′ be denoted by q, and let $C = D' - D$.

Therefore $\cos D - \cos D' = \cos D - \cos (D + C) = q$.

But $\cos (D + C) = \cos D \cos C + \sin D \sin C$, and $\cos C = 1 - \frac{1}{2} C^2$ nearly, as C is small, also $\sin C = C$.

Therefore $q = \cos D - \cos (D + C) = \frac{1}{2} C^2 \cos D + C \sin D$.

$$\text{and } C = \frac{q - \frac{1}{2} C^2 \cos D}{\sin D} = q \operatorname{cosec} D - \frac{1}{2} C^2 \cot D. \quad \ldots\ldots\ldots \text{ formula } (b')$$

VI. DEMONSTRATION OF FIRST LUNAR METHOD.

To find the correction of the Distance for Refraction: we have $h = 0$, $H = 0$, $\alpha = R$, $\beta = r$; hence (26) and (28) give, $\delta = -114'' + \epsilon' + \epsilon + \frac{1}{2} R^2 + \frac{1}{2} r^2$.

And, by formula (b'), $C = q \operatorname{cosec} D - \frac{1}{2} C^2 \cot D$.

Hence, rejecting $\frac{1}{2} C^2 \cot D$, $\frac{1}{2} R^2$, and $\frac{1}{2} r^2$ as inconsiderable; the altitudes in this method being supposed not under 7°; and taking the value of q from formula (b): We have,

$$C = \left\{\frac{r}{\cos B} . \sin A + \frac{R}{\cos A} . \sin B + c\right\} . \operatorname{cosec} D - (114'' - \epsilon' - \epsilon) . \cot D.$$

$$\text{Or } C = \left\{\frac{r}{\cos B} . \sin A + \frac{R}{\cos A} . \sin B + c - (114'' - \epsilon' - \epsilon)\right\} . (\operatorname{cosec} D - \cot D).$$

Now $\frac{r}{\cos B} . \sin A + \frac{R}{\cos A} . \sin B + c - (114'' - \epsilon' - \epsilon)$ is the auxiliary arc in Table V.,

and, since $(114'' - \epsilon' - \epsilon) (\operatorname{cosec} D - \cot D) = 114'' \tan \frac{1}{2} D$ nearly: we have

$C =$ (Aux. arc in Table V.). $\operatorname{cosec} D + 114'' \tan \frac{1}{2} D$.

Table VI. contains $C + 20''$, which is called the 1st correction. Hence, this correction added to the apparent distance will give the distance corrected for refraction $+ 20''$.

To find the correction of the distance for the moon's parallax: we have $r = 0$, $R = 0$, $h = 0$, $\alpha = P$; $57'' - \epsilon = r \tan B = 0$, $57'' - \epsilon' = R \tan A = 0$, hence $-114'' + \epsilon' + \epsilon = 0$.

Therefore, by (26) and (28), $\delta = H \sin A + \frac{1}{2} P^2 = H \sin A + \frac{1}{2} HP \cos A =$

$H (\sin A + \frac{1}{2} P \cos A) = H \sin (A + \frac{1}{2} P)$.

Hence, formula (b') gives $C = -H \sin B \operatorname{cosec} D + H \sin (A + \frac{1}{2} P) \cot D - \frac{1}{2} C^2 \cot D$, as $c = 0$.

Table I. contains $\frac{1}{2} P - R$, therefore the 1st and 2d auxiliary arcs, as found by the Rule for this method, give the first two terms of C. And, since Table VIII. contains $\frac{1}{2} C^2 \cot D + 20''$, it is evident, that by applying the Rule, we shall obtain the distance corrected for parallax $- 20''$. It is understood, however, that before applying the correction for parallax, the altitudes and distance have been previously corrected for refraction; consequently the true distance between the moon and a fixed star will thus be obtained.

To find the correction of the Distance for the parallax of the sun or a planet:

As in the case of the moon, $C = -h \sin A \operatorname{cosec} D + h \sin B \cot D$:

Now, Table VII. contains $C + 10''$, when $h = 10''$, consequently, this will give nearly the effect of the sun's parallax $+ 10''$, and to destroy the $10''$, the arc from Table VIII. is in this case increased by $10''$.

The rule for finding the effect of a planet's parallax is easily deduced, since the correction is proportional to the parallax, as appears by the above formula.

VII. DEMONSTRATION OF SECOND LUNAR METHOD.

The Rule for this method determines the true distance between the moon and a fixed star, as the correction for the parallax of the sun or a planet is found by Table VII.

Hence, formula (b') gives, $C = \left\{ \frac{r}{\cos B} \cdot \sin A - \left(H - \frac{R}{\cos A} \right) \sin B \right\} \operatorname{cosec} D +$

$$\delta \cot D + c \operatorname{cosec} D - \tfrac{1}{2} C^2 \cot D.$$

But, by (26) and (28), $\delta = H \sin A - 114'' + \varepsilon' + \varepsilon + \tfrac{1}{2} a^2 + \tfrac{1}{2} r^2 =$

$$H \sin A - (114'' - 2\varepsilon') + \varepsilon - \varepsilon' + \tfrac{1}{2} a^2 + \tfrac{1}{2} r^2.$$

Now, $114'' - 2\varepsilon' = 2R \tan A = \sin A \cdot \frac{2R}{\cos A}$; and, if we make $\tfrac{1}{2} a^2 - \varepsilon' = \tfrac{1}{2}(a - x)^2$

$= \tfrac{1}{2} a^2 - a x$, we find $x = \frac{\varepsilon'}{a}$, and $\tfrac{1}{2} a^2 - \varepsilon' = \tfrac{1}{2} \left(a - \frac{\varepsilon'}{a} \right)^2$.

$$\text{Therefore, } \delta = \sin A \left(H - \frac{2R}{\cos A} \right) + \varepsilon + \tfrac{1}{2} r^2 + \tfrac{1}{2} \left(a - \frac{\varepsilon'}{a} \right)^2.$$

$$\text{Hence } C = \left\{ \frac{r}{\cos B} \cdot \sin A - \left(H - \frac{R}{\cos A} \right) \sin B \right\} \operatorname{cosec} D + \sin A \left(H - \frac{2R}{\cos A} \right) \cot D +$$

$$(\varepsilon + \tfrac{1}{2} r^2) \cot D + c \operatorname{cosec} D + \tfrac{1}{2} \left(a - \frac{\varepsilon'}{a} \right)^2 \cot D - \tfrac{1}{2} C^2 \cot D.$$

The 1st, 2d, and 3d parts of the Rule evidently give the part of C contained in the first line of the above expression: as, $\frac{r}{\cos B}$, and $\frac{R}{\cos A}$ are the arcs contained in Table XXV., and $(\varepsilon + \tfrac{1}{2} r^2)$ cot D + c cosec D is the star's correction contained in Table XXIV.

Also, $a - \frac{\varepsilon'}{a}$ is the departure of the moon in altitude, contained in Table XXII.; consequently, from Table VIII., we obtain $\tfrac{1}{2} \left(a - \frac{\varepsilon'}{a} \right)^2 \cdot \cot D + 20''$; and, from the same Table, we also obtain $\tfrac{1}{2} C^2 \cot D + 20''$: but, as by the 2d and 6th parts of the Rule, the former is added to, and the latter subtracted from the apparent distance, the result will evidently be the same as adding $\tfrac{1}{2} \left(a - \frac{\varepsilon'}{a} \right)^2 \cot D - \tfrac{1}{2} C^2 \cot D$ to the apparent distance.

Hence, the Rule includes all parts of C.

VIII. DEMONSTRATION OF THIRD LUNAR METHOD.

By IV., $2 \cos (60° + x) = \Delta$; put $60° + x = y$; therefore $2 \cos y = \Delta$.

By formula (b), $\cos D - \delta \cos D - \cos D' =$

$$- \left(H - \frac{R}{\cos A} \right) \sin B + \left(\frac{r}{\cos B} - h \right) \sin A + c.$$

But $\cos D - \delta \cos D = \cos D (1 - \delta) = \Delta \cos D = 2 \cos y \cos D = \cos (y + D) + \cos (y - D)$.

Hence $\cos D - \delta \cos D - \cos D' = \cos (y + D) + \cos (y - D) - \cos D'$
$= \text{vers } D' - \text{vers } (y + D) - \text{vers } (y - D) + 1.$

Therefore $\text{vers } D' = -\left(H - \frac{R}{\cos A}\right) \sin B + \left(\frac{r}{\cos B} - h\right) \sin A$
$+ c + \text{vers } (y + D) + \text{vers } (y - D) - 1.$

From this formula the Rule given for the fourth Lunar method is easily deduced.

IX. DEMONSTRATION OF FOURTH LUNAR METHOD.

vers D′ — vers D = cos D — cos D′, which, by formula (*b*), is =

$$\left(\frac{r}{\cos B} - h\right) \sin A - \left(H - \frac{R}{\cos A}\right) \sin B + \delta \cos D + c.$$

Therefore, $\text{vers } D' = -\left(H - \frac{R}{\cos A}\right) \sin B + \left(\frac{r}{\cos B} - h\right) \sin A + c + \delta \cos D + \text{vers } D.$

But $H - \frac{R}{\cos A}$, and $\frac{r}{\cos B} - h$ are the first and second auxiliary arcs; consequently, the first two terms of vers D′ are the 1st and 2d departures of distance, the former of which is negative or W, and the latter positive or E. The correction *c* is applied to the 2d auxiliary arc, because it is generally additive.

The term $\delta \cos D$ is evidently the 3d departure; and is positive, or E., when the distance is less than 90°, but is negative or W, when the distance is greater than 90°, the sign being the same as that of cos D.

The first and second parts of Table XXVIII. contain, respectively, the lengths of positive and negative arcs; hence the correctness of the Rule is evident.

X. DEMONSTRATION OF FIFTH LUNAR METHOD.

By spherical trigonometry, we have

$$\cos D = \text{suvers } Z \cos A \cos B - \cos (A + B), \quad (40)$$

$$\text{and } \cos D' = \text{suvers } Z \cos A' \cos B' - \cos (A' + B'). \quad (41)$$

(40), multiplied by cos A′. cos B′, gives cos D cos A′ cos B′ =

$$\text{suvers } Z \cos A \cos B \cos A' \cos B' - \cos (A + B) \cos A' \cos B'. \quad (42)$$

(41), multiplied by cos A cos B, gives cos D′ cos A cos B =

$$\text{suvers } Z \cos A \cos B \cos A' \cos B' - \cos (A' + B') \cos A \cos B. \quad (43)$$

(43) — (42) gives, cos D′ cos A cos B — cos D cos A′ cos B′ =

$$\cos (A + B) \cos A' \cos B' - \cos (A' + B') \cos A \cos B. \quad (44)$$

(13) — (44), when divided by cos A cos B, and since $\frac{\cos A' \cos B'}{\cos A \cos B} = \Delta$, will give

$$\cos D - \cos D' = -\Delta \cos (A + B) + \cos (A' + B') + \delta \cos D.$$
$$= -\cos (A + B) + \cos (A' + B') + \delta \cos (A + B) + \delta \cos D.$$

Hence, $\text{vers } D' - \text{vers } D = \text{vers } (A + B) + \text{suvers } (A' + B') + \delta \cos (A + B) + \delta \cos D - 2.$

From this formula, the Rule for fifth method is easily deduced. It may be remarked, that the sum of the last two terms of the preceding formula is always positive: for 90° — A, 90° — B, and D, form the three sides of a spherical triangle, and therefore, 90° — A + 90° — B, or 180° — (A + B) is greater than D; hence A + B and D must either be both less than 90°, or if one of them is greater than 90°, the other must be less than 90°. In the former case, the cosines of both are positive; in the latter, the cosine of the obtuse arc is negative, but it is less than the cosine of the acute arc, since the supplement of the obtuse arc is greater than the acute arc: consequently, in both cases $\delta \cos (A + B) + \delta \cos D$ is a positive quantity.

APPENDIX.

III.

DEMONSTRATION

OF THE

RULE FOR FINDING THE TIME.

Let A = Sun's altitude, L = Latitude of Ship, P = hour angle from noon, and D = Sun's declination.

Then, by Spherical Trigonometry, $\text{vers } P = \frac{\cos (L - D) - \sin A}{\cos L \cos D}$.

But, $\cos L \cos D = \frac{1}{2} \cos (L + D) + \frac{1}{2} \cos (L - D)$,

therefore, $\frac{1}{2} \text{vers } P = \frac{\frac{1}{2} \cos (L - D) - \frac{1}{2} \sin A}{\frac{1}{2} \cos (L - D) + \frac{1}{2} \cos (L + D)}$

Now, L — D and L + D are, respectively, the difference and sum of the Latitude and Declination, attending to their names. And Table XVII. contains half-cosines, and half-sines: the cosines and sines being taken for radius 10,000, and supposed to denote seconds; these being then reduced to minutes and seconds, for the convenience of using the Table of Proportional Logarithms. Table XVIII. contains Logarithms of half-versed sines: hence, the Rule is easily deduced.

If L + D exceed 90°, its cosine becomes negative, hence the reason for the *Note* to the Rule.

APPENDIX.

IV.

CONSTRUCTION OF THE TABLES.

TABLE I.

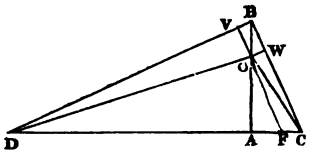
This Table contains ½ P — R, or half the Parallax of the moon in altitude diminished by the Refraction: See VI. of Appendix II.

The Log. Parallax in altitude is = Log. Horizontal parallax + Log. Cosine of apparent altitude — 10; or, it may be obtained, sufficiently exact for this purpose, by taking from a table of difference of latitude and departure, the difference of latitude, corresponding to the altitude as a course, and the horizontal parallax as a distance.

TABLE II.

1st. *To find the Reduction of the Latitude.*

Let O be the place of the observer on the surface of the Earth, C the centre of the Earth; O D a tangent to the meridian of the place, and meeting the Equatorial diameter at D; A O the ordinate passing through O; O F perpendicular to D O; A B the ordinate to a semicircle described on the Equatorial diameter; and O V, O W perpendiculars from O on D B, B C.



As O is a point in an ellipse, D B is a tangent to the Semicircle on the Equatorial diameter; and, therefore, D B C is a right angle.

It is evident that O F D = Latitude of O, the Earth being taken as a sphere, and O C D = Latitude of O the Earth being a spheroid: hence the Reduction of Latitude = O F D — O C D = F O C = D O C — D O F = D O C — D B C, (as D O F and D B C are each a right angle) = B C O + B D O.

Let L' = Latitude to a sphere.
L = Latitude to a spheroid.
A = Angle B C A.
1 = Equatorial semidiameter of Earth.
p = Polar semidiameter of Earth.
r = Radius of Earth at O = C O.

Then, $BCO = \frac{OW}{OC} = \frac{BO \cdot \sin OBC}{OC} = \frac{BO \cdot \cos A}{OC} = \frac{BO \cdot \sin A}{OC \cdot \tan A}$.

And, $VDO = \frac{VO}{DO} = \frac{BO \cdot \sin DBO}{DO} = \frac{BO \cdot \sin DBO}{OC \cdot \tan DCO} = \frac{BO \cdot \sin A}{OC \cdot \tan L}$.

Therefore, $BCO : VDO :: \frac{BO \cdot \sin A}{OC \cdot \tan A} : \frac{BO \cdot \sin A}{OC \cdot \tan L}$,

$:: \tan L : \tan A$,

$:: AO : AB$,

$:: p : 1$,

hence $VDO = \frac{BCO}{p}$; and Reduction of Latitude $= L' - L = BCO + VDO =$

$$BCO + \frac{BCO}{p} = BCO \cdot \frac{1+p}{p}.$$

But, since $AO : AB :: p : 1$,

therefore $AO : OB :: p : 1-p$,

and $OB = AO \cdot \frac{1-p}{p} = r \cdot \sin L \cdot \frac{1-p}{p}$.

Hence $BCO = \left(\frac{BO \cos A}{OC} =\right) \sin L \cos A \cdot \frac{1-p}{p}$.

But, $\cos A = \cos (L + BCO) = \cos L \cos BCO - \sin L \sin BCO$

$= \cos L - \sin L \cdot BCO$, nearly.

Therefore, $BCO = \sin L \cos L \cdot \frac{1-p}{p} - \sin^2 L \cdot BCO \cdot \frac{1-p}{p}$;

and, consequently, $$BCO = \frac{\sin L \cos L \cdot \frac{1-p}{p}}{1 + \sin^2 L \cdot \frac{1-p}{p}}$$

The Denominator is evidently a *maximum*, when $L = 90°$, and it then is $= 1 + \frac{1-p}{p} = \frac{1}{p}$: its *minimum* value is evidently $= 1$.

If therefore we assume the denominator to have its maximum value, $BCO = \sin L \cos L \cdot (1-p)$, or $= \sin 2L \cdot \frac{1-p}{2}$,

But as $p = \frac{229}{230}$, and the *maximum* value of B C O is when $L = 45°$; in which case, it is $= \frac{1-p}{2} = \frac{1}{460}$, (to radius 1), $= 7' 29''$: hence, by assuming the denominator of B C O as $=$ its *maximum* value $\frac{1}{p}$, and as the *minimum* value being 1, the error in the value of B C O can never exceed $7' 29'' \cdot \left(\frac{1}{p} - 1\right) = \frac{7' 29''}{229} = 2''$; which is sufficiently correct, as B C O is required only to the nearest *minute*.

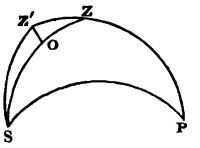
The *Reduction of Latitude* $= L' - L = B\,C\,O \cdot \frac{1+p}{p} = \sin 2L \cdot \frac{1-p^2}{2p}$, the *maximum* value of which is, when $L = 45°$, $= \frac{1-p^2}{2p} = 15'\ 0''$.

And, since $\sin 2L' - \sin 2L = \cos 2L \cdot 2(L' - L)$, nearly, it cannot exceed $2(L' - L)$ or $30'$; we may therefore assume $L' - L = \left(\sin 2L \cdot \frac{1-p^2}{2p} = \right) \sin 2L' \cdot \frac{1-p^2}{2p}$: as the greatest error cannot exceed $30' \cdot \frac{1-p^2}{2p}$, or $8''$.

Hence $B\,C\,O = \sin 2L' \cdot \frac{1-p}{2}$, and *Reduction of Latitude* $= \sin 2L' \cdot \frac{1-p^2}{2p}$.

2d. *To find the Correction of the Altitude.*

Let P be the Pole; Z, the zenith for a sphere, and Z′ the zenith for a spheroid; and S the place of the observed body.



Then Z Z′ = reduction of Latitude; Z S = observed zenith distance; Z′ S = corrected zenith distance. And, if Z′ O be drawn perpendicular to Z S, Z O = correction of zenith distance, or correction of altitude = Z Z′ cos Z.

Therefore, *Correction of altitude* = *Reduction of Latitude* . Cosine of Azimuth: it is evidently *additive*, when Z or the azimuth is *less than* 90°; and *subtractive*, when Z is *greater than* 90°.

3d. *To find the Reduction of the Moon's Equatorial Parallax.*

Since $r = C\,O = \frac{A\,C}{\cos L}$, and $A\,C = C\,B \cos A = \cos A$,

therefore $r = \frac{\cos A}{\cos L}$,

and $1 - r = 1 - \frac{\cos A}{\cos L} = \frac{\cos L - \cos A}{\cos L} = \frac{\sin L \cdot B\,C\,O}{\cos L}$ nearly, $= \tan L \cdot B\,C\,O$.

$= \tan L' \cdot B\,C\,O$, nearly.

But $B\,C\,O = \sin L' \cos L' \cdot (1 - p)$; therefore $1 - r = \sin^2 L' \cdot (1 - p)$.

And, since the parallax is proportional to the semi-diameter of the Earth, we have

$1 : r ::$ H, (the horizontal parallax at the Equator): parallax at Latitude L'.

Hence, $1 : 1 - r ::$ H : *Reduction of horizontal parallax* $= (1 - r) \cdot H$

$= \sin^2 L' \cdot (1 - p) \cdot H$,

where H may be taken = the mean parallax $57'$.

TABLE III.

1st. *To find the Augmentation of the Moon's Horizontal Semi-diameter.*

Let D = Distance of moon from centre of Earth.
d = Distance of moon from the observer.
r = Radius of the Earth.
P = Parallax at altitude A.
H = Horizontal parallax.
A = Apparent altitude.
A' = True altitude ($= A + P$).
S = Horizontal semi-diameter.
S' = Semi-diameter at altitude A.
$S' - S$ = Augmentation of semi-diameter.

Then, it is easily shown that $P = \cos A \,.\, H$, $\frac{r}{D} = H$, $D : d :: \cos A : \cos A'$, and $D : d :: S' : S$.

$$\text{Hence} \quad \frac{S'}{S} = \frac{D}{d} = \frac{\cos A}{\cos A'},$$

$$\text{and} \quad \frac{S'}{S} - 1 = \frac{\cos A}{\cos A'} - 1$$

$$\text{or} \quad \frac{S' - S}{S} = \frac{\cos A - \cos A'}{\cos A'}.$$

But $\cos A - \cos A' = \sin A \,.\, (A' - A)$, nearly $= \sin A \,.\, P = \sin A \cos A \,.\, H$;

and $\cos A' = \cos A - \sin A \cos A \,.\, H$.

$$\text{Hence,} \quad \frac{S' - S}{S} = \frac{\sin A \cos A \,.\, H}{\cos A - \sin A \cos A \,.\, H} = \frac{\sin A \,.\, H}{1 - \sin A \,.\, H}$$

$$\text{and} \quad S' - S, \text{ or } \textit{Augmentation of semi-diameter} = \frac{\sin A \,.\, H}{1 - \sin A \,.\, H} \,.\, S.$$

But, taking H = mean parallax $= 57'$, and $S = 16'$, the *maximum* value of $S' - S$ is, (when $A = 90°$), $= \frac{57'}{\text{radius} - 57'} \,.\, 16' = 16'' \,.\, 2$. But, if we assume the denominator $= 1$, instead of $1 - \sin A \,.\, H$, then the *maximum* value is $57' \,.\, 16' = 15'' \,.\, 9$: we, therefore, may assume, in all cases, that the denominator is 1; and hence,

the *Augmentation of the semi-diameter* $= \sin A \,.\, \sin 57' \,.\, 16'$.

2d. *To calculate the Dip of the Horizon.*

Let h = Height of the eye in feet.
r = Radius of the Earth.

Then, the Visible horizon being a tangent to the Earth, drawn from the eye; and the True horizon, a perpendicular to the radius of the Earth passing through the eye: it is easily shown that the *cosine* of the angle contained between these horizons, or of the *Dip of the Horizon* is $= \frac{r}{r + h}$.

$$\text{Hence} \quad 1 - \cos \text{Dip} = \frac{h}{r + h} = \frac{h}{r}, \text{ nearly,}$$

$$\text{or} \quad 2 \sin^2 \tfrac{1}{2} \text{Dip} = \frac{h}{r},$$

$$\text{or} \quad \tfrac{1}{4} \text{Dip}^2 = \frac{h}{r},$$

$$\text{and} \quad \text{Dip} = \sqrt{\frac{h}{\frac{1}{4} r}}, \text{ to radius 1,}$$

$$\text{and } \textit{Dip} \text{ in seconds} = \text{seconds in radius} \,.\, \sqrt{\frac{h}{\frac{1}{4} r}}$$

But $r = 3956$ miles, and seconds in Radius $= \frac{180° \times 60 \times 60}{3.1416}$,

Therefore *Dip* in seconds $= \sqrt{h} \cdot \frac{\text{Seconds in Radius}}{\sqrt{(1978 \times 5280)}}$,

and Log. *Dip*, in seconds $= \frac{1}{2}$ Log. h + Const. Log. 1.804993.

But Terrestrial Refraction being $= \frac{1}{10}$ of intercepted arc $= \frac{1}{10}$ of *Dip*; and as the Visible horizon is raised by the Refraction nearer to the True horizon: hence the *Dip*, corrected for Refraction, will be $\frac{9}{10}$ of the *Dip* as formerly calculated. But Log. $\frac{9}{10} = -1.954243$, hence Log. *Dip*, in seconds $= \frac{1}{2}$ Log. h + Const. Log. 1.759236.

3d. *To calculate the Parallax in altitude.*

This is easily obtained from the formula: *Parallax in altitude* = Horizontal parallax . cosine altitude: in the case of the Sun, the horizontal parallax is 9″.

TABLE IV.

The *Mean refraction*, R, is $= 57''$ cot (A + 3 R), where A is the apparent altitude.

TABLE IV.*

The *Correction* of the mean refraction for any temperature t is $= \frac{(50° - t) \cdot R}{350° + t}$. And the correction for any height h of the barometer is $= \frac{(h - 29.6) \cdot R}{29.6}$.

TABLE V.

This Table contains an Auxiliary arc $= \frac{r}{\cos B} \cdot \sin A + \frac{R}{\cos A} \cdot \sin B + c - (114'' - \epsilon' - \epsilon)$: (See VI. of *Appendix* II.): where $c = \alpha\beta \cdot \frac{\cos (A + B) \cos (A - B)}{\cos A \cos B}$, (see V. (36) of *Appendix* II).

TABLE VI.

This Table contains the first correction of Method I. = (Aux. arc in Table V.) cosec D + 114″ tan ½ D + 20″: (See VI. of *Appendix* II.). This table, therefore gives the correction of the distance for refraction increased by 20″.

TABLE VII.

This Table contains a correction for horizontal parallax 10″; and which may, therefore, be taken for the Sun's correction, without any error of importance: the horizontal parallax of the Sun being 9″ instead of 10″, we ought, in strictness, to diminish the correction in this Table by one-tenth of it, to find the correction for the parallax of the Sun.

The correction of distance for parallax of moon is, (VI. of *Appendix* II.), $= -$ H sin B cosec D $+$ H sin (A $+ \frac{1}{2}$ P) cot D $- \frac{1}{2}$ C^2 cot D. And in the same manner, we may find the correction for parallax h of the sun or planet, (neglecting $\frac{1}{2}\,p$ and the term $\frac{1}{2}$ C^2 cot D, as inconsiderable), $= -\,h$ sin A cosec D $+\,h$ sin B cot D. And by making $h = 10''$, and adding $10''$, the corrections in this Table are found: they are evidently proportional to h.

TABLE VIII.

This Table contains $\frac{1}{2}$. (*Departure*)^2 cot D $+ 20''$; where the *Departure* is the argument in the side column, and is $=$ C, the *departure* of Distance (see VI. of *Appendix* II.), or $=$ the *departure* of the moon in altitude $= a - \frac{c'}{a}$ (see VII. of *Appendix* II.)

TABLE IX.

This Table contains Logarithmic Sines, Tangents, and Cosecants.

TABLE X.

This Table is called a Table of proportional Logarithms for 3 hours or 3 degrees, because it is useful in finding the fourth term of a proportion, where one of the terms is 3 hours, or degrees: it may also be used in all cases, when none of the terms exceeds 3 hours or degrees. The Logarithm in this Table corresponding to any given quantity is found by subtracting the Logarithm of the seconds in the quantity from the Logarithm of the seconds in 3 hours or 3 degrees, or from Log. 4.0334: and is therefore the Logarithm of the quotient of 3 hours or 3 degrees divided by the given quantity.

Now, if $a : b :: m : n$, and c be a constant quantity: then

$$\frac{c}{a} : \frac{c}{b} :: \frac{c}{m} : \frac{c}{n},$$

$$\text{hence} \quad \text{Log.}\frac{c}{n} = \text{Log.}\frac{c}{b} + \text{Log.}\frac{c}{m} - \text{Log.}\frac{c}{n} :$$

where if c is 3 hours or degrees, the Logarithms are proportional Logarithms;

$$\text{and if } a = c = 3 \text{ hours or degrees, then} \quad \text{Log.}\frac{c}{n} = \text{Log.}\frac{c}{b} + \text{Log.}\frac{c}{m} - \text{Log. } 1$$

$$\text{or} \quad \text{P. Log. } n = \text{P. Log. } b + \text{P. Log. } m.$$

Hence, when the first term of a proportion is 3 hours or degrees, the Proportional Logarithm of the 4th term is $=$ the sum of the Proportional Logarithms of the 2d and 3d terms.

Again, if $b = a$ sin A, then $\frac{c}{b} = \frac{c}{a \sin A} = \frac{c}{a}$. cosec A; and Log. $\frac{c}{b}$ = Log. $\frac{c}{a}$ + Log. cosec A, or P. Log. b = P. Log. a + Log. cosec A: and the same principle is applicable in other cases.

TABLES XI., XII., XIII., XIV., XV., and XVI.

These Tables do not require any explanation as to their construction.

TABLE XVII.

This Table contains Half-cosines and Half-sines: the natural cosines and sines being taken for radius 10,000, and reckoned as seconds, for the purpose of adapting them to the table of Proportional Logarithms. It is therefore evident that the sum of any two Half-cosines, cannot exceed 10,000″ or 2° 46′ 40″; and, consequently in all cases, the table of Proportional Logarithms may be used in the Rule for finding the time.

TABLE XVIII.

This Table contains the Logarithms of half the Versed Sines of the hours, minutes, and seconds forming the Argument of the table.

TABLE XIX.

This Table contains Proportional Logarithms for 24 hours or degrees; and is therefore useful when one of the terms of a proportion is 24 hours. The Logarithms in this Table are found by subtracting the Logarithm of the number of minutes in the hours or degrees, and minutes of the Argument of the Table, from the Logarithm of the minutes in 24 hours or degrees, or from const. Log. 3.1584: or, by subtracting the Logarithm of the number of seconds in the minutes and seconds of the Argument from the same Constant Logarithm: these being respectively applicable according as the Argument is made to express hours or degrees at the top, and minutes at the side; or minutes at the top, and seconds at the side.

The use of this Table is similar to that of Table X.

TABLE XX.

This Table does not require any explanation.

TABLE XXI.

This Table contains Proportional Logarithms from 1 hour or degree, and is therefore similar to Tables X. and XIX.: the const. Log. used in constructing the Table is the Logarithm of 3600, or Log. 3.5563.

TABLE XXII.

This Table contains the *Departure of the moon in altitude,* used in the second Lunar method. It is $= \alpha - \frac{\epsilon'}{\alpha}$, (see VII. of *Appendix* II.); or, if α be expressed in minutes, and ϵ' in seconds, the departure is $= \alpha - \frac{\epsilon'}{60 \sin \alpha}$: where α may be taken for the mean parallax 57′.

TABLE XXIII.

This Table contains $c = \alpha\beta \cdot \frac{\cos(A + B)\cos(A - B)}{\cos A \cos B}$,

$= \beta \sin \alpha \cos(A + B)\cos(A - B) \sec A \sec B$: (see V. (36) of *Appendix* II.)

TABLE XXIV.

This Table contains the star's correction $= (\epsilon + \frac{1}{2} r^{\epsilon}) \cot D + c \operatorname{cosec} D$: (see VII. of *Appendix* II.), where c is contained in Table XXIII.

TABLE XXV.

This Table contains $\frac{R}{\cos A}$: which, at high altitudes, is $= \frac{57'' \cot A}{\cos A} = \frac{57''}{\sin A}$.

TABLE XXVI.

This Table is a duplicate of that given in Table II.

TABLE XXVII.

This Table contains a specimen of δ, the construction of which is explained in III. of *Appendix* II.

TABLE XXVIII.

This Table consists of two parts: the first part having for its Argument an arc which is named E, or positive; and the second part contains an arc, which is named W, or negative.

The first part contains the actual length of the arc, which is the Argument of the Table, for radius 1,000,000: the last five figures only being retained.

If we denote the length of the *seconds* of an arc s, and that of the *degrees* and *minutes* by m; then the length of the whole arc is $m + s$; and, if the arc is negative, we may add $100{,}000 - (m + s)$, instead of subtracting $m + s$, the last five figures only being retained.

Now, in the second part of the Table, we have $99{,}000 - m$, and $1{,}000 - s$: consequently, when these are added together, we obtain $100{,}000 - (m + s)$; which is, as stated above, the length of a negative arc, retaining only the last five figures.

APPENDIX.

V.

DEMONSTRATIONS

OF THE

RULES FOR FINDING THE SMALL CORRECTIONS

OF A

LUNAR DISTANCE.

1st, *The correction for the Spheroidal figure of the Earth.*

THE correction of the Lunar distance for the Moon's parallax is $C = -H \sin B \operatorname{cosec} D + H \sin (A + \frac{1}{2} P) \cot D - \frac{1}{2} C^2 \cot D$, by the formula given in the demonstration of the first Lunar method, Appendix, page 175: the first and second terms of which are evidently the first and second arcs of the Departure of distance, found by Rule 7, page 28. Hence, it is evident that any change in the horizontal parallax will produce a proportional change in the amount of these terms, or of the amount of the first and second arcs above referred to: as the horizontal parallax is a factor of each term, and the other factors are constant. And as the change of parallax is a reduction of the parallax, the corresponding change of the amount of the first and second arcs of the Departure of distance is also a reduction of this amount; when, therefore, it is applied directly to the distance, it must be made of an opposite name to the Departure of distance. Hence, Rule 1, page 39, is deduced.

The first arc found by Rule 7, page 28 is $-H \sin B \operatorname{cosec} D$, as given in the formula, Appendix, page 175, as above referred to. Hence the correction of this arc corresponding to d B, a small change in B, will be found by taking the differential of the first arc, and is $= -H \operatorname{cosec} D \cos B \cdot \frac{d B}{\text{radius}} =$ first arc. $\cot B \cdot \frac{d B}{\text{radius}}$. But the first arc . cot B is the Difference of Latitude as found in Rule 2, page 39; hence the correction of the first arc will be found by multiplying this Difference of Latitude by $\frac{d B}{\text{radius}}$, all the quantities being expressed in minutes. But radius is nearly $= 60^0 = 60 \times 60$ minutes; hence the correction of first arc in seconds $= 60 \times$ the Difference of Latitude $\times \frac{d B}{60 \times 60} =$ the Difference of Latitude $\times \frac{d B}{60} =$ the Difference of Latitude $\times \frac{\frac{5}{3} d B}{100} = \frac{\text{the Difference of Latitude}}{100} \times \frac{5}{3} d B$. But $\frac{5}{3} d B = \frac{3}{2} d B \cdot \frac{10}{9} = \frac{5}{3} d B$ nearly, as the correction is small, and this approximation cannot differ above $1''$ from the truth. Hence, Rule 2, page 39, is deduced: it is evident that by increasing the Sun's correction by two-thirds of itself, would be more correct than increasing it by its half as stated in the Rule; but the increased accuracy, thereby obtained, is unimportant.

Rule 3, page 39, is deduced in the same manner from the formula for the second arc of the Departure of distance, as given at page 175 of the Appendix.

2d, *Correction for the Heights of the Thermometer and Barometer.*

From the construction of Table IV.,* Appendix, page 183, it is evident that the corrections of both the Refractions in altitude are proportional to these refractions. And by the formula in the demonstration of the first Lunar method, Appendix, page 175, it appears the correction of the distance for Refraction will change nearly proportional to the whole change of the refractions in the altitudes of the bodies. Hence the Rule, page 41, is deduced.

3d, *Correction for the elliptical form of the limb of the Moon or Sun.*

If from the true place of the moon, a perpendicular be drawn on the apparent distance between the bodies, there will be formed a right angled triangle, of which the angle opposite to the perpendicular will be the angle at the Moon contained between a vertical circle passing through the Moon, and the great circle passing through the Sun and Moon. The hypotenuse of this triangle is the parallax of the Moon in altitude; and the base is the correction of the distance corresponding to the parallax of the Moon. Hence, Rules 1 and 2, page 42, are deduced.

Rule 3, page 42, is evidently deduced from the theorem in Spherical Trigonometry, that the Sines of the sides of a spherical triangle are proportional to the Sines of the opposite angles.

From the explanation given at page 42, it appears that the limb of the Sun or Moon assumes an elliptical form, owing to refraction. The major semi-axis, or equatorial semidiameter of this ellipse is the semidiameter of the Sun or Moon at the given altitude; and the minor semi-axis, or polar semidiameter, is less than this by the difference between the Refraction corresponding to the altitude of the centre of the Sun or Moon, and the Refraction corresponding to the altitude of the highest point on the limb, which latter altitude differs from the former by the semidiameter of the Sun or Moon, or by 16′ nearly. Hence, for any given altitude of the centre of the Sun or Moon, take from Table IV. the corresponding Refraction; and, from the same Table, take the Refraction corresponding to an altitude 16′ greater than the given altitude: the difference between these refractions will be the difference between the equatorial and polar semidiameters of the ellipse formed by the limb of the Sun or Moon. These differences are given in the first column of Table, page 43, being under 0^0 as the angle at the Sun or Moon.

The formula given in the construction of the Table for finding the reduction of the Moon's equatorial parallax, Appendix, page 181, is $1 - r = \sin^2 L' (1 - p)$; where 1 is assumed as the equatorial semidiameter of an ellipse, p the polar semidiameter, and r the semidiameter to a point of the ellipse whose Latitude is L'; where L' is the complement of the angle contained between p and r. Hence the difference between the equatorial semidiameter and any other semidiameter r, of an ellipse, is equal to the difference between the equatorial and polar semidiameters multiplied by the square of the cosine of the angle contained between the polar semidiameter and the semidiameter r. But the angle at the Sun or Moon is the angle contained between the vertical or polar semidiameter, and that semidiameter which is a part of the great circle passing through the two bodies. It follows, therefore, that if the quantities in the first column of Table, page 43, be multiplied by the square of the cosine of the angle at the top of any other column, the quantities in the latter column will be found. Hence, Rule 4, page 43, is deduced.

THE END.

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CERTIFICATES

IN FAVOUR OF

JAMES GORDON, A.M.,

TEACHER OF MATHEMATICS, NAVIGATION, AND NAUTICAL ASTRONOMY, MINORIES, LONDON:

WHEN A

CANDIDATE FOR THE PROFESSORSHIP OF MATHEMATICS AT BELFAST.

ERRATA.

Page 10, in Note to Rule 3, for page vii, *read* page 60.
„ 16, in Rule 2, for page v, *read* page 58.
„ 17, in Rule 3, for page v, *read* page 58.
„ 28, in Rule 1, for pages ii and iii, *read* pages 58 and 59.
„ 28, in Rule 2, for pages iii and iv, *read* pages 59 and 60.
„ 29, in Rule 10, for page iv, *read* page 60.
„ 41, in Rule, for pages i and ii, *read* pages 57 and 58.
„ 54, line 6, for 69° 27′ 32″, *read* 69° 27′ 34″.
„ 173, line 3, under (25), for $\alpha\ \beta$ tan A, *read* $\alpha\ \beta$ tan A tan B.
„ 175, line 7, under VI., should be,

$$C = \left\{ \frac{r}{\cos B} \cdot \sin . A + \frac{R}{\cos A} \cdot \sin B + c - (114'' - \epsilon' - \epsilon) \right\} . \operatorname{cosec} D - (114'' - \epsilon' - \epsilon) . (\operatorname{cosec} D - \cot D).$$

and, that he has conducted the Seminary with the utmost credit to himself, with eminent success in the education of the Students, to the entire satisfaction and approbation of the Patrons and Visitors of the School, and with the warm support of the Public.

Given at the Council Chamber, Aberdeen, and the City Seal hereto affixed, this Twenty-seventh day of March, 1832 years.

JAS. HADDEN,
Provost and C. M.

No. II.

Certificate by the late ROBERT HAMILTON, LL.D., F.R.S.E., *Professor of Mathematics in Marischal College and University, Aberdeen, and Author of the following Works:—A Treatise on the National Debt; a Treatise on the Progress of Society; Mathematical Tables; a Complete System of Merchandise; a Treatise on Arithmetic, &c. &c.*

Marischal College, Aberdeen, 17th Nov. 1825.

I HEREBY certify, that Mr. JAMES GORDON attended a complete Course in this University, and obtained the de-

ROBERT HAMILTON,
Professor of Mathematics, M. College.

No. III.

Certificate by JOHN CRUIKSHANK, Esq., *Professor of Mathematics in Marischal College and University, Aberdeen.*

Marischal College, Aberdeen, 4th April, 1832.

I CERTIFY, that JAMES GORDON, A.M. while a Student in the First and Second Mathematical Classes in this University, during Sessions 1820-1, and 1821-2 respectively, merited my highest approbation in every respect, and greatly distinguished himself by his progress in his studies. In 1822, he gained, by comparative trial, the Mathematical Bursary, an annual prize of £50, open to Students who have attended the above two Classes. During Sessions 1822-3, and 1823-4, he attended the Third and Fourth Mathematical Classes, then taught by the late Dr. Robert Hamilton; and, in 1824, the Senatus Academicus conferred upon him a Gold Medal, appointed by the Founder of the said Bursary, to be given, at the close of their attendance, to such Mathematical Bursars as "have a fine genius for Mathematics," and are "deemed to excel remarkably therein,"—an honour conferred only

CERTIFICATES

IN FAVOUR OF

JAMES GORDON, A.M.,

TEACHER OF MATHEMATICS, NAVIGATION, AND NAUTICAL ASTRONOMY, MINORIES, LONDON:

WHEN A

CANDIDATE FOR THE PROFESSORSHIP OF MATHEMATICS AT BELFAST.

No. I.

Certificate by the Town Council of Aberdeen.

THESE certify that JAMES GORDON, A.M., a native of this City, has been Master of the Public Commercial and Mathematical School of Aberdeen, under the Patronage of the Magistrates and Council, since the Month of May, 1826; that he was appointed to that situation after a long and strict comparative trial before a Committee of Professors of Marischal College, during which he highly distinguished himself in the different branches of Mathematical learning, including Algebra, Plane and Solid Geometry, Plane Trigonometry, Mensuration of Heights, Distances, Surfaces and Solids, Land-surveying, Geography, the Doctrine of the Globes, Navigation and Spherical Trigonometry, with its application to Nautical and Astronomical Problems; that he has all along taught these and other branches of Mathematics, besides Commercial Subjects, and occasionally the higher parts of Mathematical Science; and, that he has conducted the Seminary with the utmost credit to himself, with eminent success in the education of the Students, to the entire satisfaction and approbation of the Patrons and Visitors of the School, and with the warm support of the Public.

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Marischal College, Aberdeen, 17th Nov. 1825.

I HEREBY certify, that Mr. JAMES GORDON attended a complete Course in this University, and obtained the degree of A.M. in April, 1823, having given full satisfaction to every Master he attended, not only by the regularity of his conduct and diligent application to his studies, but by a display of superior talent and more than ordinary proficiency. That he gained the Mathematical Bursary by Competition, at the commencement of Session 1822-3; and, after having applied, under my direction, to the Study of the higher parts of that Science, during that and the following Session, and exhibited superior talent, he obtained the honorary reward of a Gold Medal, appointed by the Founder of the Bursary, to be given only on the condition of being certified by the Professor of Mathematics to have made some discovery or improvement of his own, deserving of that reward, and which Medal had only been granted once before, twenty-nine years ago. I further certify that he has maintained an unblemished character and good behaviour under difficult circumstances, and fully believe he will acquit himself with credit in any situation which it may fall to his lot to occupy.

ROBERT HAMILTON,
Professor of Mathematics, M. College.

No. III.

Certificate by JOHN CRUIKSHANK, Esq., *Professor of Mathematics in Marischal College and University, Aberdeen.*

Marischal College, Aberdeen, 4th April, 1832.

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once before, viz. in 1795, although instituted in 1771. Since he left the University, Mr. Gordon has prosecuted the study of the higher branches of Mathematics with very great success, his attainments being such as justly entitle him to be called eminent in that Science.

In 1826, after considerable previous experience in teaching, Mr. Gordon was appointed, by the Magistrates of Aberdeen, to the Office of Master of the Public Commercial and Mathematical School of this City, in consequence of the report of Examiners, of whom I was one, and before whom he underwent, along with other two Candidates of great merit, a comparative trial, which lasted above four days. The duties of this office he has since then discharged with great steadiness, assiduity, and success. He has shewn unwearied zeal for the improvement of his Pupils; his arrangements for maintaining order and exciting emulation, have been very judicious; and he has shewn the happy talent of conveying instruction and explaining difficulties with great perspicuity. Of these matters, I have had good opportunities of judging, having been present officially at all the Public Examinations and Competitions for prizes in his School; and many of my Pupils, in the several Mathematical Classes, having been under his Tuition, both before and during their attendance in the University. As one proof of his success in teaching, I may state, that our highest annual Mathematical prize, the Bursary above-mentioned, has been awarded at seven of the last eight annual trials, to Students who had been Pupils of his.

From Mr. Gordon's eminent attainments in Mathematical Science, his steadiness and industry, and his experience and success in teaching, I consider him qualified to fill the Office of Professor of Mathematics, for which he is a Candidate, in the Belfast College, with great credit to himself and the College, and usefulness to the Public.

JOHN CRUIKSHANK,
Professor of Mathematics.

No. IV.

Certificate by OLINTHUS GREGORY, LL.D., *Professor of Mathematics in the Royal Military Academy of Woolwich, and Fellow of the Royal Astronomical Society; also, Corresponding Associate of the Academy of Dijon, Honorary Member of the Literary and Philosophical Society of New York; of the New York Historical Society; of the Literary and Philosophical, and Antiquarian Societies of Newcastle-upon-Tyne; of the Cambridge Philosophical Society; of the Institution of Civil Engineers, &c. &c.*

HAVING been informed by Mr. JAMES GORDON, of Aberdeen, that he is a Candidate for the Mathematical Chair in the Institution at Belfast, vacant by the removal of Dr. Thomson to Glasgow, I most readily supply him with my humble Testimonial.

From various Mathematical Papers of Mr. Gordon, some of which are addressed to myself, while others have been published, I have no hesitatation in characterizing his scientific talents as of a high order, and his taste as formed upon the best models; while his acquirements are evidently sound and extensive. I have not had the opportunity of knowing his habits as a preceptor; but, if they should in any way accord with his Theoretical skill (to which, I doubt not, other Testimonials will speak), he will be well qualified to occupy the important station in the College, sustained with such distinguished ability by Dr. Thomson.

OLINTHUS GREGORY, LL.D.
Professor of Mathematics,
Royal Military Academy.

Woolwich, March 26th, 1832.

No. V.

Letter from ALEXANDER ANDERSON, LL.D., *Professor of Mathematics in the East India Military Seminary.*

East India Military Seminary,
14th March, 1832.

MY DEAR SIR,

I HAD the pleasure of receiving your letter, informing me that you intended to offer yourself as a Candidate for the Mathematical Chair in the Royal Institution of Belfast, and requesting to know, whether from my knowledge of you, I could express a favourable opinion of your qualifications for the honour of holding that situation.

My personal knowledge of you commenced soon after you had distinguished yourself, by gaining, by Public Competition, the situation which you now hold. I had previously learned, either from my venerable friend, the late Dr. Hamilton, or from Mr. Cruikshank, his Assistant, Professor of Mathematics in Marischal College, Aberdeen, that you had gained, by Competition with your Class-fellows, the Mathematical Bursary; and, that, soon afterwards, on exhibiting farther proof of great talent and proficiency as a Student of Mathematics, the Senatus Academicus were pleased to mark their high approbation of your merit, by presenting you with the Gold Medal—an honour which is conferred only in unusual cases; and, in fact, had not been granted to any one for thirty years before.

Since that time, during my annual visits to Aberdeen, or otherwise, I have had frequent opportunities of forming a fair estimate of your character. You have furnished me with occasional means of judging of your merit as a Mathematician, by sending me solutions, not only of Problems which you had prescribed yourself, but to two which I had requested you to do for me. I have read your excellent little work, "The Elements of Arithmetic," and your demonstration of the Theorems of Lagrange, and Laplace, for the expansion of Functions, both of which have been before the Public for some time:—in all these, there are, in my opinion, evident marks of the original talent and proficiency which had distinguished you at the University. They are all highly creditable to you; and, certainly not less so, because they have been drawn up after the fatigue of seven or eight hours of daily duty in teaching a numerous School.

On the honourable Testimony of some of my most respected friends in Aberdeen, and on personal knowledge in one instance, I have ample reason to believe, that your success in communicating scientific knowledge to your Pupils has been very great, or generally co-extensive with their ability for learning, and the time they have remained

under your tuition. I receive the assurance of my friends with the greater confidence in this case, because, in "the Elements of Arithmetic," where clear and obvious illustration is the greatest merit of a teacher, you have scarcely left one solitary explanation throughout the whole work, the force and application of which the learner will not easily apprehend. And I observe, that this skill, or art of demonstration, is not confined to Arithmetic, but is generally remarkable in your solutions of Problems in the higher branches of Mathematics.

I beg to assure you, that it will afford me sincere pleasure, if my humble opinion can be of any service to you. I am convinced you are well qualified for the efficient discharge of the important duties of the situation for which you are about to offer yourself as a Candidate; and that your qualifications are such as to afford great promise of future excellence and public advantage, if it should be your good fortune to obtain the appointment. With my best wishes for your success,

I remain,
MY DEAR SIR,
Yours very truly,
ALEXANDER ANDERSON, LL.D.

To JAMES GORDON, Esq.,
Public Commercial and Mathematical School, Aberdeen.

No. VI.

Letter from GEORGE PEACOCK, Esq., M.A., F.R.S., F.G.S., F.R.A.S., *and* F.C.P.S., *Fellow and Tutor of Trinity College, Cambridge, and author of the following works:—A Treatise on Algebra; the Notes to, and part of, the Translation of Lacroix, on the Differential and Integral Calculus; a Collection of Examples of the Applications of the Differential and Integral Calculus, &c.*

Trinity College, Cambridge, Feb. 14, 1832.

SIR,

I BEG leave to thank you for your letter enclosing a demonstration of Lhuiller's Theorem; and also for a former letter, containing a demonstration of the Theorem of Lagrange. I think your demonstrations very complete, and possessing considerable elegance of form, and they give proof of a very great familiarity with some of the higher parts of Analysis. I have also referred to some of the papers of which you state yourself to be the author, and they furnish very favourable specimens of the progress you have made in the study of the higher parts of Mathematics. I should certainly think, from these specimens, that you are qualified, as far as knowledge is concerned, for filling the Mathematical Chair at the Belfast Institution, and I heartily wish you success in your canvass to obtain it. As I have not the advantage of a personal acquaintance with you, it is quite impossible for me to speak of your other qualifications for such a situation.

Believe me,
SIR,
Your most obedient Servant,
GEO. PEACOCK.

To MR. JAMES GORDON,
Commercial and Mathematical School, Aberdeen.

No. VII.

Certificate by the Rev. ROBERT J. BROWN, A.M., *Professor of Greek in Marischal College and University, Aberdeen.*

Marischal College, March 19, 1832.

I HEREBY certify, that as an official Visitor of the Public Mathematical, Geographical, and Arithmetical School, in this City, taught by Mr. J. GORDON, I have several times visited that Seminary, and have had reason, in common with the other Visitors, to express my very warm approbation of the talent, zeal, and diligence of the teacher, and of the attainments of his Pupils. Further, it gives me great pleasure to have an opportunity of stating, that Mr. Gordon is considered, by the most competent judges, as a Mathematician of no ordinary abilities; that he is most ardent in the pursuit of the Science to which he has devoted himself, and that I have every reason to regard him as an individual highly qualified by his experience, his habits, his acquirements, and his general character, for being a public instructor in his own particular department of knowledge.

R. J. BROWN,
Profr. of Greek.

No. VIII.

Letter from WILLIAM WALLACE, Esq., A.M., F.R.S.E., *Professor of Mathematics in the University of Edinburgh.*

Edinburgh, 25th January, 1832.

DEAR SIR,

In answer to your letter requesting my opinion as to your fitness to teach the Mathematical Sciences in the Academy at Belfast, I most willingly declare, that I entertain a high opinion of your acquirements in the Mathematical Sciences. Besides, what I learned when I had the pleasure of seeing you in Edinburgh, from the communications which I have received and seen, I believe that you would fulfil the duty to be performed at Belfast, with credit to yourself, and advantage to the Establishmeut.

Wishing you all success in your application,

I remain,
DEAR SIR,
Your most obedt. Servant,
W. WALLACE.

To JAMES GORDON, Esq.,
Commercial and Mathematical School, Aberdeen.

No. IX.

Certificate by WILLIAM KNIGHT, LL.D., *Professor of Natural Philosophy in Marischal College and University, Aberdeen.*

Marischal College, Aberdeen.
26th March, 1832.

I CERTIFY, that Mr. JAMES GORDON passed through a regular course of Study in this University, with the esteem and approbation of all the Professors, during the

period of four years; after which, he received, in 1823, the degree of A.M. That he has since been constantly employed in Teaching Public Classes in all the branches of Mathematical Science, to which he has applied very great natural powers of mind, and uncommon industry. In the year 1826, he submitted to, and went through, a very strict trial of nearly five days for the situation of Master of the Mathematical School of Aberdeen, and acquitted himself so admirably in all the branches of Examination, that he was unanimously recommended by the Examiners (of whom I was one) to the Magistrates of the City, as well qualified to discharge the duties of that office, which he obtained from the Patrons in consequence of this report. That it is further consistent with my personal knowledge, that Mr. Gordon has since been constantly improving himself in the Mathematical Sciences, in which his equal in proficiency is rarely to be found; that the ability and order displayed by him in conducting the Seminary over which he presides, are very great, and have been successfully exerted in rearing many excellent Scholars; and that the habits of Teaching which he has acquired and put in practice, render him an exceedingly proper person to receive the charge of a higher situation, like that which he is now a Candidate for in the Royal Institution of Belfast.

WILLIAM KNIGHT, LL.D.,
Prof. of Nat. Philosophy.

No. X.

Letter from JOHN TULLOCH, Esq., *Professor of Mathematics in King's College and University, Aberdeen.*

King's College, 10th April, 1832.

DEAR SIR,

HAVING understood that you intend to become a Candidate for the Professorship of Mathematics in the Belfast Institution, I cheerfully join your other friends in bearing my humble testimony to your being eminently qualified for performing aright the duties of the office to which you aspire. To your great attainments in Mathematical Science, you have added the art of communicating your knowledge with ease and success to your Pupils; and this latter qualification cannot fail to attract the favourable notice of the Electors; for it not unfrequently happens, that a man may possess great stores of Literature and Science, and yet be deficient in the happy art of communicating his knowledge to others. The progress which you have already made in the higher branches of Analysis, gives us the promise of your soon attaining to distinguished eminence in a Science, in the cultivation and extension of which, Lagrange, Laplace, and others, have acquired an imperishable name. I cannot, therefore, but desire to see you occupy a situation in which you would have more time to devote to those studies than you now have.

Sincerely wishing you success in every thing that can contribute to your welfare,

I am,
DEAR SIR,
Yours very truly,
J. TULLOCH.

To Mr. GORDON, &c. &c.

No. XI.

Certificate by the Rev. JOHN MURRAY, A.M., *Minister of North Parish, Aberdeen.*

I HAVE much pleasure in bearing Testimony to the talents, qualification, and character, of JAMES GORDON, A.M., Teacher of the Public Commercial and Mathematical School in this city, as Candidate for the Professorship of Mathematics in the Royal Academical Institution of Belfast. Mr. Gordon's attainments in Mathematics are so distinguished, while his method of communicating knowledge is so approved and successful, that he would do credit to any Academy or University in the Empire. Securing, in no common degree, the respect and attachment of his Pupils, he imbues them with something of his own enthusiastic ardour and indefatigable industry, in the prosecution of Science, the benefit and effects of which appear in their general progress, which is equally creditable to their teacher and themselves.

Mr. Gordon's character is entirely suitable to the important office of an instructor of youth; and I consider him in all respects eminently qualified for the honourable situation after which he aspires.

JOHN MURRAY, A.M.,
Minister of North Parish, Aberdeen.

Aberdeen, 23d May, 1832.

No. XII.

Certificate by JAMES DAVIDSON, M.D., *Professor of Natural and Civil History in Marischal College and University, Aberdeen.*

Aberdeen, 20th May, 1832.

I HEREBY certify, that Mr. JAMES GORDON, Master of the Public Mathematical School of this City, was regularly educated at Marischal College, and distinguished himself in all the Classes, as a most correct, attentive, and highly talented Student;—that during the time he attended my Class, I had every reason to be satisfied with his application, abilities, and progress in learning; and that I have had opportunities of knowing privately, and of ascertaining publicly, his great attainment to the prosecution of Mathematical Studies, but particularly in the higher departments, and the almost unrivalled progress he has made in general Analysis, and its application to the illustration of many of the more difficult investigations in Physical Science.

And I farther certify, that I have had a son of mine under his tuition; and from the progress he made, and from the excellent mode Mr. Gordon has of instructing his Pupils, I have no doubt of his being eminently qualified for the situation at Belfast, for which he is at present a Candidate.

JA. DAVIDSON, M.D.
H. N. and C. P.

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* The Court of Directors of The Honourable the East India Company have been pleased to grant the Author a Reward of £50, and have ordered 50 Copies for the use of the Indian Navy.

RECOMMENDATIONS.

I.—*By the Astronomer Royal.*

THE *mathematical part*, as far as I see, *is correct* to terms of the second order, inclusively: which is the proper limit for Lunar calculations.

The practical application of the First Method is easy enough. It is *more accurate* than Mrs. Taylor's method; and the increase of trouble is so little that I should think any good navigator would prefer it: *I would do so myself.*

I am well satisfied with your First Method; and, I think, it may safely be used for lower altitudes than you have proposed.

(Signed) G. B. AIRY.

Note.—The above was written by PROFESSOR AIRY in 1839, when a specimen of the Tables was published, extending only to Altitudes of 15°; whereas they now extend to Altitudes of 7°. PROFESSOR A.'s remark regarding the present method being *more accurate* than Mrs. Taylor's method, equally applies to the similar methods of Thomson and others, as they are all founded on the same principles.

II.—*Certificate numerously signed by Experienced Commanders of Vessels.*

WE, the undersigned, having examined a specimen of Lunar and Time Tables, by JAMES GORDON, A.M., containing methods for correcting a Lunar Distance, and a method of finding the Time at Sea: Certify, that, in as far as known to us, these methods are new; and, that they will, in our opinion, be highly useful in conducting the calculations for finding the Longitude at Sea.

As the first two Lunar methods are short, and do not require proportional parts, a knowledge of them may soon be required; and the correcting a Lunar Distance by means of them will be an easy and brief process.

The method of finding the Time at Sea is the shortest and easiest of any known to us.

We, therefore, cordially testify that the Tables will be an important acquisition to practical Navigators.

III.—*Letter from Admiral Sir Arthur Farquhar.*

I HAVE no hesitation in saying that, with practical seamen, in working Lunar observations, brevity is of the utmost consideration; provided correctness can be, at the same time, secured; and which, in my opinion, your method completely accomplishes.

(Signed) ARTHUR FARQUHAR.

IV.—*Letter from Lieutenant Reid, R.N.,*

ONE OF THE OFFICERS IN CAPTAIN PARRY'S EXPEDITION TO DISCOVER THE NORTH WEST PASSAGE.

I HAVE examined your method of clearing a Lunar Distance, having applied it to several of my observations, and found the results were very correct and satisfactory.

I am much pleased with your new method, as being so plain, short, and correct; also of its requiring no proportioning, the operation being conducted by inspection, and the common Logarithms extended to only four places of decimals: properties of great importance to the practical navigator, from the great liability to err in using proportional parts.

Your method, by avoiding the use of a table of triple entry, such as that of Thomson and others, will be appreciated by practical seamen; and only requires to be known to be universally adopted by them.

(Signed) ANDREW REID.

V.—*Letter from George Grainger, Esq., late H.E.I.C.S.*

I HAVE carefully examined your method of working Lunar Distances, and have solved various examples by means of your Tables. I have no hesitation in saying that the method is, as far as I am aware, perfectly new; and possesses decided advantages over every other method with which I am acquainted. The method only requires the aid of a few special Tables, and the whole calculation is performed by inspection, and by means of the common Logarithmic tables, retaining only four places of decimals: it cannot, therefore, but recommend itself, at once, to practical seamen, from its extreme simplicity.

Farther, your concise Tables give your method a decided advantage over such works as that of Mendoza Rios; as also over those of Captain Thomson, Mrs. Taylor, &c., which contain a table of triple entry.

Your method being sound in principle, easy of application, requiring no hesitation from the computer, and one which none can fail to remember after solving a few examples: I believe I am only doing justice to yourself, and an essential service to seamen, in bearing the strongest testimony to its superiority over every other method which I have used or seen.

(Signed) GEORGE A. GRAINGER.

VI.—*Letter from Captain Anderson, of Aberdeen.*

I HAVE with much pleasure examined your method of working Lunar Distances, by applying it to many examples deduced from my own observations; and, by comparing the results deduced from the trigonometrical process with those obtained from your Tables, I have in every instance found your method gives an accurate and easy solution.

Conceiving, therefore, that your method, by avoiding such troublesome triple entry Tables as that of Thomson and others, and giving a short solution conducted entirely by inspection, will be acceptable to every practical seaman, I feel confident that, if once known, its merits will be generally appreciated.

(Signed) ROBERT ANDERSON.

Thus, if the Apparent Distance is 21° 19′, the altitude of the Star, 6° 29′, and the altitude of the Moon, 24° 9′: the nearest of these in the Table are Dis., 20°, ☼'s alt., 6°, ☽'s alt., 24°; and, if the corresponding correction is taken, it is 6′ 5″; whereas it should be 5′ 25″, or 40″ less, which would give *an error* of about 20 MILES in *Longitude*.

To find the correction 5′ 25″, the requisite calculation is as follows:

Under Distance 20°,

☼'s alt. 6° and ☽'s alt. 24° give Correction	= 6′ 5″
1° : 29′ :: − 1′ 9″ : Variation for 29′ of ☼'s alt., . .	= − 33
1° : 9′ :: + 14″ : Variation for 9′ of ☽'s alt., . .	= + 2
Therefore, Dist. 20°, ☼'s alt. 6° 29′, and ☽'s alt. 24° 9′ give Correction	= 5 34

In the above, the correction, opposite to ☽'s alt. 24° and under ☼'s alt. 6°, is 6′ 5″; and opposite same alt. of Moon and under ☼'s alt. 7°, it is 4′ 56″. Therefore, the variation for 1° of ☼'s alt. is − 1′ 9″. Again, under ☼'s alt. 6° and opposite to ☽'s alt. 24°, the correction is 6′ 5″; and under same alt. of Star, and opposite to ☽'s alt. 25°, it is 6′ 19″. Therefore, the variation for 1° of ☽'s alt. is + 14″.

Again, under Distance 24°,

☼'s alt. 6° and ☽'s alt. 24° give Correction	= 5′ 33″
1° : 29′ :: − 1′ 4″ : Variation for 29′ of ☼'s alt. . .	= − 31
1° : 9′ :: + 14″ : Variation for 9′ of ☽'s alt. . . .	= + 2
Therefore, Dist. 24°, ☼'s alt. 6° 29′, and ☽'s alt. 24° 9′ give Correction	= 5 4

Hence,

as Dist. 20° and given altitudes give Correction . . .	= 5′ 34″
and Dist. 24° and given altitudes give Correction . . .	= 5 4
Variation for 4° of Dist. . . .	= − 30
1° 19′ :: − 30′ : Variation for 1° 19′ of Dist. . . .	= − 9″
Dist. 20° and given altitudes give Correction . . .	= 5′ 34″
, given Dist. 21° 19′ and given altitudes give Correction .	= 5 25

fter performing all the above proportions, the correction, in many cases, is nd; as appears from examining the tabular differences. Thus, for pposite to ☽'s alt. 24°, we have under ☼'s alt. 6°, the correction , it is 4′ 56″; under 8°, it is 4′ 9″; under 9°, it is 3′ 28″, &c.: the h are − 1′ 9″, − 47″, − 41″, &c. From which it appears that common not give the correct variation for the minutes of altitude not found in ust be corrected by the method of second differences, on account of es varying considerably.

fore, as that of Thomson's would often occasion important errors if n; and to proportion accurately is troublesome. To remove this ficulty in proportioning, we have formed two Tables (viz., V. and tead of a table of triple entry: from the first an auxiliary arc is the second of these tables with this arc and the apparent the Distance is obtained. These tables contain arcs which ther; consequently, to use them, requires merely inspection: *riority* of our method."

2.

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PREFACE to the NEW LUNAR and TIME TABLES.

"NUMEROUS methods having been proposed to perform the calculations in finding the Longitude at Sea by Chronometers and Lunar Distances, the Author feels called upon to give his reasons for thinking that the present work will be found worthy of the patronage of practical Navigators, as being superior to the other works of a similar kind presently used by them.

The common method of finding the Longitude by A CHRONOMETER is not very complicated; but the new method here given is shorter, as it merely requires a Table of Half Sines and Half Cosines (Table XVII.), consisting of only 7 pages, and two logarithms taken from the common table of Proportional Logarithms, to find the logarithm of the apparent time, without using the Polar distance. The Author, therefore, flatters himself that it will be found to be *the easiest* and *shortest method* yet published.

With regard to the methods of finding the Longitude from LUNAR DISTANCES, several methods are now in use. Those which give the *Correction* to be applied to the Apparent Distance, in order to obtain the True Distance, are the most highly esteemed by practical Navigators. As these methods are all similar to each other, although they differ slightly in form, we shall particularize only one of them, viz., THOMSON'S METHOD, in order to show what is deemed to be the superiority of the present Tables over others.

First, as regards *the mode of constructing the Tables*. Referring to Thomson's Tables, BARON ZACH (in the Memoirs of the Royal Astronomical Society, VOL. IV., PART II.,) makes the following statement:—'The Author (Captain Thomson) does not explain the principles on which they are founded. I have not been able to discover the grounds on which the *third correction* is computed; and, indeed, it appears it has been determined in an indirect and empirical manner.' This is confirmed by MR. COLEMAN (who has lately published Tables similar to those of Thomson), and claims having suggested the aforesaid indirect and empirical method to Captain Thomson. On this we may remark that Tables which are calculated by a long and tedious indirect method, such as that referred to, are very liable to contain errors: owing to the chance of the computer making mistakes being greater than when he uses direct mathematical formulæ, which afford him checks at certain intervals to test the accuracy of his calculations. *The first point of superiority*, therefore, which is claimed for the present Tables, is that they are constructed from *Mathematical formulæ discovered by the* AUTHOR, and which have been examined by *Mathematicians of the highest celebrity*, and *found to be correct*.

Second, that Captain Thomson's Tables *cannot give correct results in all cases* may be thus proved. The *third correction* depends upon the parallax of the Moon, whereas the changes in this element are entirely neglected in Thomson's Tables.

Thus, if the Apparent Distance be 20°, the apparent altitude of the Moon 20°, and the apparent altitude of the Star 20°, also the Moon's horizontal parallax 53′: then Captain Thomson's method of calculating his *third correction* is as follows.

The True Distance must be calculated by any direct method: and it will be found to be = 19° 58′ 4″. Then the *first* and *second* corrections must be found: they are 4° 7′ 0″, and 5° 49′ 48″. These corrections being added to the apparent distance 20°, and 10° rejected, the sum is 19° 56′ 48″: the difference between which and the True Distance 19° 58′ 4″ is 1′ 16″ = the *third correction*. But, in Thomson's Table of the third correction, it is 1′ 28″: showing that he has not calculated his correction for parallax 53′.

Again, if we take the same altitudes and distance as above, but suppose the Moon's horizontal parallax to be 61′, the True Distance will be found to be 19° 57′ 57″: and the *first* and *second* corrections = 3° 59′ 0″ and 5° 57′ 20″. The sum of these corrections and Apparent Distance 20°, rejecting 10°, is 19° 56′ 20″: the difference between which and the True Distance 19° 57′ 57″, is 1′ 37″ = *third correction*.

Hence, when the Moon's parallax is 53′, the *third correction* is 1′ 16″; but, when the parallax is 61′, it is 1′ 41″, the difference of which is 21″.

Instead, therefore, of the correction remaining constant whatever the parallax of the Moon may be, it is shown here to vary 21″: neglecting the parallax, therefore, might occasion an error of 21″ in the Distance, or about 11 miles in Longitude.

The present method, however, takes into account the parallax of the Moon, and thus avoids the error above specified: this is *the second point of superiority* of our method.

Third, as regards *the form of the Tables*. Captain Thomson gives his *third correction* in the form of a table of triple entry: the arguments being the altitude of the Sun or Star, from 6° to 86°, at the top of the pages, the altitude of the Moon, from 6° to 86°, in the side column, and the Apparent Distance at the top of the two pages containing these altitudes. This form of a table often causes considerable trouble in finding the correction from it.

Thus, if the Apparent Distance is 21° 19′, the altitude of the Star, 6° 29′, and the altitude of the Moon, 24° 9′: the nearest of these in the Table are Dis., 20°, ☌'s alt., 6°, ☽'s alt., 24°; and, if the corresponding correction is taken, it is 6′ 5″; whereas it should be 5′ 25″, or 40″ less, which would give *an error* of about 20 MILES in *Longitude*.

To find the correction 5′ 25″, the requisite calculation is as follows:

Under Distance 20°,	
☌'s alt. 6° and ☽'s alt. 24° give Correction	= 6′ 5″
1° : 29′ : : — 1′ 9″ : Variation for 29′ of ☌'s alt., . .	= — 33
1° : 9′ : : + 14″ : Variation for 9′ of ☽'s alt., . .	= + 2
Therefore, Dist. 20°, ☌'s alt. 6° 29′, and ☽'s alt. 24° 9′ give Correction	= 5 34

In the above, the correction, opposite to ☽'s alt. 24° and under ☌'s alt. 6°, is 6′ 5″; and opposite same alt. of Moon and under ☌'s alt. 7°, it is 4′ 56″. Therefore, the variation for 1° of ☌'s alt. is — 1′ 9″. Again, under ☌'s alt. 6° and opposite to ☽'s alt. 24°, the correction is 6′ 5″; and under same alt. of Star, and opposite to ☽'s alt. 25°, it is 6′ 19″. Therefore, the variation for 1° of ☽'s alt. is + 14″.

Again, under Distance 24°,	
☌'s alt. 6° and ☽'s alt. 24° give Correction	= 5′ 33″
1° : 29′ : : — 1′ 4″ : Variation for 29′ of ☌'s alt. . .	= — 31
1° : 9′ : : + 14″ : Variation for 9′ of ☽'s alt. . . .	= + 2
Therefore, Dist. 24°, ☌'s alt. 6° 29′, and ☽'s alt. 24° 9′ give Correction	= 5 4
Hence,	
as Dist. 20° and given altitudes give Correction . . .	= 5′ 34″
and Dist. 24° and given altitudes give Correction . . .	= 5 4
Variation for 4° of Dist. . . .	= — 30
4° : 1° 19′ : : — 30′ : Variation for 1° 19′ of Dist. . . .	= — 9″
But Dist. 20° and given altitudes give Correction . . .	= 5′ 34″
Therefore, given Dist. 21° 19′ and given altitudes give Correction .	= 5 25

But, even after performing all the above proportions, the correction, in many cases, is not accurately found; as appears from examining the tabular differences. Thus, for Dist. 20° and opposite to ☽'s alt. 24°, we have under ☌'s alt. 6°, the correction = 6′ 5″; under 7°, it is 4′ 56″; under 8°, it is 4′ 9″; under 9°, it is 3′ 28″, &c.: the differences of which are — 1′ 9″, — 47″, — 41″, &c. From which it appears that common proportion would not give the correct variation for the minutes of altitude not found in the table: as this must be corrected by the method of second differences, on account of the tabular differences varying considerably.

Such a table, therefore, as that of Thomson's would often occasion important errors if it is used by inspection; and to proportion accurately is troublesome. To remove this cause of error and difficulty in proportioning, we have formed two Tables (viz., V. and VI.), of double entry instead of a table of triple entry: from the first an auxiliary arc is found; and, by entering the second of these tables with this arc and the apparent distance, the correction of the Distance is obtained. These tables contain arcs which vary very little from each other; consequently, to use them, requires merely inspection: this is *the third point of superiority* of our method."

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EX. 1. February 10th, 1851, in Latitude 30° N. and Longitude 60° W. by account, at $2^h\ 40^m\ 11^s$ P.M., ship's time, the observed distance between the Sun and Moon was 107° 12′ 30″ when the chronometer showed $6^h\ 40^m\ 20^s$ P.M., Greenwich time, the observed altitude of the Sun's lower limb being 31° 30′, and that of the Moon's lower limb 30° 26′, the eye being 20 feet above the sea, and the index error of the sextant that measured the distance + 1′ 14″. Required the mean time at Greenwich when the distance was taken?

Obs. alt. ☽	30°	26′			Obs. alt. ☉	31°	30′	
Cor.	+	12			Cor.	+	12	
	30	38	log.	2928		31	42	log. 2795
Greenwich time,	6^h	40^m	20^s	Tables A & B				4924
Obs. Dis. cor.	107°	13′	44″	1st log.	4962			2d log. 9·9789
1st Cor.	4°	50′	35″	P. L.	1·2814			P. L. 0 7508
2d Cor.	4	28	3					
3d Cor.		2	26					
True Dist. of limbs	106	35	8					
Dist. in Ephemeris	106	13	52	log.	7165	Time	6^h	0^m 0^s
Difference	0	26	16	P. L.	9276			
				P. L.	6441	gives	0	40 51
				Mean time at Greenwich			6	40 51

EX. 2. May 6th, 1851, in Latitude 51° 10′ N., and Longitude 50° 30′ W. by account at $2^h\ 30^m\ 30^s$ P.M. ship's time, the observed distance between the Sun and Moon was 66° 9′ 45″, the observed altitude of the Sun's lower limb being 34° 10′, and that of the Moon's lower limb 43° 9′, the eye being 18 feet above the sea, and the instrument having no index error. Required the mean time at Greenwich when the distance was taken?

				Obs. alt. ☽	43°	9′	Obs. alt. ☉	34°	10′			
Time at ship,	2^h	30^m	30^s	Cor.	+	12		Cor.	12			
Longitude in time,	3	22	0		43	21	log.	1634	34 22	log.	2483	
Greenwich time,	5	52	30	Tables A & B				4879			4879	
Obs. dist.	66	9	45	1st log.		3658				2d log.	9·9630	
1st Cor.	5°	17′	18″	P. L.		1·0171				P. L.	0·6992	
2d Cor.	4	24.	1									
3d Cor.		1	34									
True distance of limbs . . .	65	52	38	log.	7273		Time	3^h	0^m 0^s			
Distance in Ephemeris . . .	64	20	0	P. L.	2885							
Difference,	1	32	38	P. L.	0158		Gives	2	53 35			
				Mean time at Greenwich,				5	53 35			